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MAY 2

The Engineer.

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VOL. CXLVII.—No. 3826] LONDON: FRIDAY EVENING, MAY 10, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

MAINS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 31st May, 1929, for LOW-PRESSURE HOT WATER HEATING and SERVICE MAINS, &c., at the State Institution, Eampton, Retford.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1862

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 30th May, 1929, for ACCELERATED LOW-PRESSURE HOT WATER HEATING and SUPPLY at the "Midland" Telephone Exchange, Birmingham.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1861

Crown Agents for the COLONIES.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/732.—CIVIL ENGINEER REQUIRED by the GOVERNMENT of CEYLON for appointment as Irrigation Engineer for three years' service and prospect of permanency. Salary £500, rising to £900 a year by annual increments of £40 (£600 a year on attaining 30 years of age). Free quarters and free passages provided. Candidates, unmarried, 26 to 31 years of age, must have passed examination to qualify for Associate Membership of the Institution of Civil Engineers or hold professional qualifications recognised by the Institution as exempting from Parts A and B of that examination, and have had at least three years' practical experience on Waterworks, Drainage or Harbour and Dock Works.

Apply at once by letter, stating age and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/732. 1879

Military College of SCIENCE, WOOLWICH.

APPLICATIONS are INVITED for the POST of DEMONSTRATOR in the Mechanical Engineering Branch of the Military College of Science, Woolwich. Salary £300-£20-£400 inclusive. The appointment will be terminable by three months' notice by either side.

Candidates should possess a University Honours Degree, and have specialised in Mechanical Engineering; experience in Automobile Engineering desirable. The successful candidate will be required to give lectures as well as demonstrate.

If otherwise suitable, preference will be given to ex-Service applicants.

Applications, giving full particulars of qualifications and enclosing copies of testimonials, and inquiries for further particulars should be addressed to the ASSISTANT COMMANDANT, Military College of Science, Woolwich, S.E. 18, not later than 31st May, 1929. 1860

Administrative County of LONDON.

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

APPLICATIONS are INVITED for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms (T. 3) 300 may be obtained from the Education Officer (T. 3), the County Hall, S.E. 1 (stamped addressed envelope necessary), to whom the form must be returned by 18th June, 1929.

MONTAGU H. COX,
Clerk of the London County Council.
1574

University of the Witwatersrand, JOHANNESBURG, SOUTH AFRICA.

LECTURER IN CIVIL ENGINEERING.

APPLICATIONS are INVITED for the above POST.

Experience in Testing Materials and ability to conduct Laboratory Classes will be a recommendation.

SALARY.—£464 per annum, rising by annual increments of £26 5s. to £569 per annum. Participation in the Provident Fund is compulsory.

TRANSPORT.—£60 will be allowed for transport expenses, subject to a proportionate refund in the event of the lecturer terminating his agreement within 3 years of the date of assumption of duty.

DUTIES.—The successful applicant will be required to assume duty on the 8th August or as soon as possible thereafter.

Candidates should state age and give full particulars of academic career and practical experience.

Applications, together with copies of testimonials, all in triplicate, must reach the SECRETARY, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar-square, London, W.C. 2, from whom further particulars may be obtained, not later than Tuesday, 4th June, 1929. 1856

The Engineer

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PUBLIC NOTICES

Technical Assistants.

TWO MECHANICAL ENGINEERS (unpensionable). Salary £150, rising to £250 per annum plus variable bonus (present total about £232 to £336). Must be British subjects. Age 24½-27 years. Preference and age concession to ex-Service men. Degree in Engineering or equivalent examination certificates and suitable workshop training essential.

Application forms, returnable by 8th June, 1929, from CHIEF SUPERINTENDENT OF ORDNANCE FACTORIES, Royal Arsenal, Woolwich, S.E. 18. 1877

Borough of Bexhill.

CORPORATION WATERWORKS.

The Corporation invite TENDERS for the LAYING and JOINTING of approx. 1540 YARDS of 4in. CAST IRON WATER MAIN in the parish of Herstmonceux, in the Hailsham Rural District.

Plans may be seen and specification and form of Tender obtained at the Water Engineer's Office, Town Hall, Bexhill-on-Sea, upon receipt of a deposit of One Guinea, which will be returned after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders.

Sealed Tenders, endorsed "4in. Water Main," on the prescribed form, together with priced schedule, must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 15th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill.
29th April, 1929. 1770

Borough of Bexhill.

CORPORATION WATERWORKS.

The Corporation invite TENDERS for the SUPPLY of approx. 1540 YARDS of 4in. C.I. PIPES and about a TON of C.I. SPECIALS.

Specification, schedule and form of Tender may be obtained at the Water Engineer's Office, Town Hall, Bexhill-on-Sea.

Sealed Tenders, endorsed "Tender for 4in. Water Pipes," must be delivered at the Town Clerk's Office, Town Hall, Bexhill-on-Sea, not later than Noon on the 15th May, 1929.

The Council do not bind themselves to accept the lowest or any Tender.

S. J. TAYLOR,
Town Clerk.

Town Hall, Bexhill.
29th April, 1929. 1771

PUBLIC NOTICES

Biggleswade Water Board, BEDFORDSHIRE.

STANDPIPE FOR INCREASING PRESSURE.

TENDERS are INVITED for CONSTRUCTION and FIXING of a STANDPIPE at Topiers Hill Reservoir.

Plans, specification, schedule of quantities and form of Tender may be obtained from the undersigned upon payment of a deposit of £2 2s., which will be returned upon receipt of a bona fide Tender.

Tenders, endorsed "Tender for Standpipe," to be delivered to the undersigned before Noon on 5th June 1929.

The Board shall not be bound to accept the lowest or any Tender.

HENRY CHAUNDLER,
Clerk to the Board.
2, London-road, Biggleswade. 1871

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 29th May, TENDERS for the SUPPLY of : FENCING MATERIALS.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White House,
91, Petty France, Westminster, S.W. 1,
8th May, 1929. 1863

Loughborough Corporation WATERWORKS.

The Corporation of Loughborough invite TENDERS from contractors for the ERECTION of a FILTER-HOUSE with Concrete Foundations and the ERECTION complete of a BATTERY of PATERSON PRESSURE FILTERS at the Nanpanton Waterworks, together with CONCRETE SETTLING TANK and the PROVISION and LAYING of the necessary CAST IRON MAINS.

The drawings and specification may be seen on or after the 14th May and copies of the schedule of works obtained from the Corporation's Consulting Engineer, Mr. F. W. Hodson, M. Inst. C.E., at Bank Chambers, Loughborough, on deposit of cheque for Five Guineas, which will be refunded to firms making bona fide Tenders on return of the documents.

Tenders are to be sent to the undersigned not later than Tuesday, the 11th day of June, 1929.

The Corporation do not bind themselves to accept the lowest or any Tender.

Dated this 8th day of May, 1929.

HARRY PERKINS,
Town Clerk.
Town Hall, Loughborough. 1872

PUBLIC NOTICES

Brentford Union.

The Guardians are prepared to invite TENDERS for :—

TWO NEW BOILERS, either Vertical or Economic Dry-back Type, capacity 6000 lb. of steam per hour each.

A WATER SOFTENING PLANT, capacity 2000 gallons per hour.

About 600 YARDS of 4in. CAST IRON and WROUGHT IRON WATER MAIN and TWO STEAM-DRIVEN PUMPS

at their West Middlesex Hospital, Isleworth, Middlesex.

Firms wishing to Tender in separate sections to the plans and specifications prepared by the Guardians' Consulting Engineer, Mr. W. M. Binny, A.M.I.C.E., M. Cons. E., are requested to send their names to the Clerk to the Guardians with reference to similar recent work carried out by them at other institutions, and, in the first place, to examine at the Consulting Engineer's Office, 39, Carlton-road, Putney, S.W. 15, the specification and plans showing the proposed work, after which a set of plans and specifications will be provided to each of the firms selected to Tender, a deposit of £5 being required at the Clerk's office, which will be returned on receipt of a Tender properly filled in.

Applications to be allowed to Tender must be in by the 21st May instant. Tenders must be delivered at the Clerk's offices by Noon, 25th June, 1929.

The Guardians do not bind themselves to accept the lowest or any Tenders.

By Order,
F. E. HARMSWORTH,
Clerk to the Guardians.

Toolands House,
34, Twickenham-road,
Isleworth, Middlesex.
6th May, 1929. 1831

Metropolitan Borough of SAINT PANCRAS.
ELECTRICITY DEPARTMENT.

TENDERS are INVITED for the SUPPLY and FIXING of an ELECTRIC MOTOR-DRIVEN CENTRIFUGAL PUMP capable of discharging 1,500,000 gallons per hour of canal water for condensing purposes.

Specification and drawing may be obtained on the payment of £1, which will be returned on receipt of a bona fide Tender, from the offices of the Electricity Department, 57, Pratt-street, Camden Town.

The Council do not bind themselves to accept the lowest or any Tenders.

F. V. CREED,
Town Clerk.
Town Hall, Pancras-road, N.W. 1. 1838

Metropolitan Borough of SAINT PANCRAS.
ELECTRICITY DEPARTMENT.

TENDERS are INVITED for the ERECTION of an ADDITION to the CONDENSING WATER PUMPING STATION, including Pump House Inlet, Screen Pits and Canal Wall, also Reinforced Concrete Additions to the Discharge Outlet to the Canal.

Specifications and drawings may be seen at the offices of the Electricity Department, 57, Pratt-street, Camden Town, and forms of Tender obtained on the payment of the sum of £1, which will be returned on receipt of a bona fide Tender.

The Council do not bind themselves to accept the lowest or any Tender.

F. V. CREED,
Town Clerk.
Town Hall, Pancras-road, N.W. 1. 1839

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. RAILWAY TICKETS.
2. SPARE PARTS for TRAIN LIGHTING CELLS.
3. V.I.R. COTTON and SILK-COVERED COPPER and GALVANISED IRON WIRE.
4. WATER CRANES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Railway Tickets," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 24th May, 1929, in respect of Specifications Nos. 1 and 4, and 31st May, 1929, in respect of Specifications Nos. 2 and 3.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1 and 2, and of 5s. for each copy of Specifications Nos. 3 and 4.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.
91, Petty France, Westminster, S.W. 1.
8th May, 1929. 1878

Borough of Weymouth and MELCOMBE REGIS.

DREDGING FOREMAN REQUIRED, to Take Charge of 10in. Suction Cutter Dredger at Weymouth. Previous experience of similar work essential.

The engagement will commence as soon after the applications have been received as possible, and the appointment will be in the first instance for a probationary period of three months, and thereafter subject to one month's notice on either side.

Applications, accompanied by full particulars of experience, wages required and copies of recent testimonials, to be sent to the TOWN CLERK, Municipal Buildings, Weymouth, on or before the 20th May, 1929.

Weymouth, 7th May, 1929. 1858

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PUBLIC NOTICE

Beckenham Urban District COUNCIL.

The Beckenham Urban District Council invite Engineering Firms specialising in the Design and Installation of Dust Destructor Plant to submit SCHEMES and TENDERS for ERECTION of (A) NEW DUST DESTRUCTOR, or (B) the RECONSTRUCTION and EXTENSION of the existing DESTRUCTOR at the Electric Generating Station, Churchfield-road, Beckenham.

Full particulars, plan and forms of Tender may be obtained on application to Mr. H. Storr Best, Surveyor, Council Offices, Beckenham, on or after May 13th, on payment of a deposit of £5 (cheque to be made payable to the Beckenham District Council), which will be refunded on the receipt of a bona fide Tender. Tenders, endorsed "Tender for Dust Destructor," to be delivered to the undersigned not later than Noon on June 24th, 1929. The Council do not bind themselves to accept the lowest or any Tender.

By Order,
F. W. GEDNEY,
Clerk of the Council.

Council Offices,
Beckenham, Kent,
May 9th, 1929. 1882

Metropolitan Water Board.

TENDERS FOR THE CONSTRUCTION OF A REINFORCED CONCRETE SUCTION TANK AND INCIDENTAL WORKS AT THE BATTERSEA WORKS, KIRTLING-STREET, BATTERSEA, S.W.11

The Metropolitan Water Board invite TENDERS for the CONSTRUCTION of a REINFORCED CONCRETE SUCTION TANK of 300,000 gallons capacity; the LAYING of a 30in. diameter OVERFLOW PIPE and the CONSTRUCTION of a FOREBAY; the BREAKING OUT and TAKING UP of about 65 TONS of C.I. PIPES; and the MAKING of consequential CONNECTIONS; all at their Battersea Works, Kirtling-street, Battersea, London, S.W. 11.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities, may be obtained on and after Monday, 13th May, 1929, from the Chief Engineer, on production of an official receipt for the sum of £5, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board, and endorsed "Tender for Battersea Suction Tank," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 3rd June, 1929.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board:
173, Rosebery-avenue, E.C. 1,
3rd May, 1929. 1816

The Assam-Bengal Railway

COMPANY, Limited, is prepared to receive TENDERS for:—

DOGSPIKES.

Specifications and Tender forms may be obtained at the offices of the Company, Bishopsgate House, 80, Bishopsgate, E.C. 2. A fee of £1 1s. is charged for each specification, which cannot under any circumstances be returned.

Tenders must be delivered at the Company's offices not later than Noon on Thursday, the 23rd May, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
THOS. C. BRETT,
Secretary.

7th May, 1929. 1851

The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of:—

5 LOCOMOTIVE BOILERS,

as per specification to be seen at the Company's offices.

Tenders, addressed to the undersigned, and marked "Tender for Boilers," with name of firm tendering, to be lodged not later than Noon on Tuesday, the 28th day of May, 1929.

For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
W. R. IZAT,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2, 6/5/1929. 1829

Commonwealth of Australia.

APPLICATIONS are INVITED from PHYSICISTS and ELECTRICAL ENGINEERS for APPOINTMENT to the STAFF of the Radio Research Board of the Commonwealth Council for Scientific Research. Applicants preferably should hold a University Degree with Honours and have had special training in some branch of radio research.

Four appointments will be made. Two of the appointees will be located at the University of Sydney, where they will work under the direction of Professor Madsen, Director of the Radio Research Board, and two at the University of Melbourne under the direction of Professor Laby.

In the first instance one Sydney appointee will be expected to specialise on fading and distortion and the other on atmospherics. Of the two Melbourne appointees one will in the first instance specialise on modulation and the other on atmospherics.

Salaries will range from £400 to £600 per annum, dependent on qualifications.

The initial programme of research covers three years, but a longer period of investigation may be involved.

Applications, giving full particulars of training, previous experience, age, and date of availability, accompanied by not more than four testimonials and also giving an indication of preference for the various positions, should reach Mr. F. L. McDOUGALL, Representative in Great Britain of the Commonwealth Council for Scientific and Industrial Research, Australia House, Strand, London, W.C. 2, not later than the 26th May. 1840

Nigerian Electricity Supply CORPN., LTD.

CHIEF ELECTRICAL ENGINEER.

APPLICATIONS are INVITED for the POSITION of CHIEF ELECTRICAL ENGINEER to this Company.

Candidates must have had a good technical training and subsequent experience in charge of hydro-electric plants of at least 10,000 kW capacity, and also of modern high-tension transmission and distribution systems. Age limits 35 to 45.

Preference will be given to candidates who can show a successful record of service abroad in work of this character.

The Engineer appointed must give his whole time to the services of the Company and must be prepared to live in Nigeria within a short distance of the power plant. A house will be provided by the Company.

He will be required to proceed to Nigeria shortly after his appointment, in order to superintend construction work now going on and subsequently to take over the operation of the plant.

Commencing salary £1200 per annum.

The length of the tour will be 18 months, with liberal leave allowance on completion of tour. First-class passage out and home will be provided.

Applications, endorsed "Chief Electrical Engineer," stating age, training, previous experience, and enclosing copies of testimonials, to be sent to the office of the Corporation by first post on Saturday, 25th May, 1929.

NIGERIAN ELECTRICITY SUPPLY CORP., Ltd.
Anglorient House,
31 and 33, Bishopsgate, London, E.C.2.
1855

YARROW HOME and HOSPITAL FOR CHILDREN BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after illness.

In these days of high cost of living, people of limited means are sometimes placed in a difficulty when their children are ill or need operations and afterwards require a change of air and much careful attention during convalescence. It cannot be too well known that the Yarrow Home and Hospital for Children, Broadstairs, Kent, was founded specially for the children of those who are not too well endowed with this world's goods. At this Home a child recovering from illness or an operation, or needing a long course of medical or surgical treatment, receives, amid the happiest possible surroundings and companionship, careful nursing and attention, such as could ordinarily only be obtained at expensive nursing homes. There are beds for fifty boys between the ages of four and twelve years, and for fifty girls between the ages of four and fourteen years. In special cases these age limits may be exceeded by two years. The fee is one guinea per week and travelling expenses. Applications for the entrance of patients are welcomed from professional people, such as members of the Institution of Civil Engineers, architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the merchant navy, school masters, university professors, &c. The London office is at 116, Victoria-street, Westminster, and the Secretary will be pleased to send full particulars to anyone who is interested.

PUBLIC NOTICES

Waterford Harbour.

The Commissioners for Improving the Port and Harbour of Waterford REQUIRE the SERVICES of a fully qualified experienced TEMPORARY ASSISTANT ENGINEER, to carry out under the direction of the Harbour Engineer a survey of portion of the River Suir about 2500ft. long by 700ft. wide and situate about 3 miles from Waterford City.

Only engineers who are fully qualified and are experienced in tidal survey and sounding work, are good draughtsmen, and conversant with taking out clay and rock quantities, need apply.

Applications, stating age, experience, qualifications, and accompanied by copies of testimonials, with salary required, to be addressed to the Secretary and General Manager, Waterford Harbour Commissioners, on or before the 11th May, 1929.

Canvassing of members of the Board will disqualify a candidate.

For any further particulars apply to the Harbour Engineer, Harbour Engineer's Office, Waterford.

AUSTIN A. FARRELL,
Secretary and General Manager.

Harbour Office, Waterford,
24th April, 1929. 1763

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a PRODUCTION and PROGRESS ENGINEER for Motor Accessory Factory. Age 25 to 30.—Details of previous experience, technical knowledge and salary required, to Box 8921, Gilbert Advertising, Ltd., 14-18, Holborn, E.C. 1. 1819 A

WANTED, RATE FIXER for Tank and Light Boiler Works in East London. Applicants must have a good knowledge of this class of work, be able to read drawings and fix suitable piecework prices.—Address, with full particulars of experience, age, and wages required, 1834, The Engineer Office. 1834 A

A FIRM of CONSULTING CHARTERED ENGINEERS, Westminster, REQUIRE an ENGINEERING ASSISTANT experienced in the design and construction of Sewerage and Waterworks. Must be a good surveyor and leveller, a neat draughtsman, and able to prepare quantities. Commencing salary £250. Appointment subject to one month's notice.—Address, stating age and experience, with copies of three recent testimonials, before 15th May, P5822, The Engineer Office. P5822 A

A VACANCY Exists in a British Firm of Marine Diesel Engine Manufacturers for a REPRESENTATIVE to obtain orders. Applicants must have a thorough practical and technical knowledge of the Construction and Running of both the Two and Four-stroke Types of Diesel Engines. State age, experience, and salary required, and forward copies of testimonials.—Address, 1812, The Engineer Office. 1812 A

ASSISTANT ENGINEER REQUIRED for Waterworks near London. Sound theoretical and practical knowledge of Steam, Oil and Electric Pumping Machinery; used to design of buildings, &c.; able handle men.—Address, giving full details, age, salary required, 1827, The Engineer Office. 1827 A

ASSISTANT PLANT ENGINEER, Young Capable man, age about 25, with up-to-date experience in modern production methods and maintenance of plant, REQUIRED by large firm of Engineers in West London.—Address, stating full details of training and experience, age, salary, &c., 1846, The Engineer Office. 1846 A

ASSISTANT to WORKS MANAGER REQUIRED for works in the South of England. Must have had experience in the production of Heavy Commercial Motor Vehicles in modern works.—Address by letter, giving full particulars of experience, age, and salary required, 1848, The Engineer Office. 1848 A

DESIGNER REQUIRED, Capable Scheming and designing Packaging Machinery. State experience, age, salary. Replies treated in strictest confidence.—Address, D. F. M., c/o Dixon's, 195, Oxford-street, London, W. 1. 1825 A

ENGINEER REQUIRED for Excavation and Concrete Work and Light Constructional Steel Work Erection in the field.—Full particulars of qualifications and experience to F. W. MARTIN, Stricklands-road, Stowmarket, Suffolk. 1837 A

ENGINEER REQUIRED to Manage Quarries in Norway. English company. Must be fully qualified, public schoolboy, and have mechanical or electrical and preferably mining and/or quarry experience. Age about 35.—Address, with full particulars, salary required, &c., 1864, The Engineer Office. 1864 A

ENGINEER WANTED, About 25 Years of Age, of good education, who has had shop experience, to assist Works Manager in production. Improving position for right man.—Address, 1817, The Engineer Office. 1817 A

ENGINEERING ASSISTANTS and DRAUGHTSMEN REQUIRED for temporary engagement in Consulting Engineer's Office in London. Applicants should be good draughtsmen and capable of preparing drawings, specifications and bills of quantities for breakwaters, quay walls, lighthouses, locked canals and general engineering work.—Address, stating age, salary required, and particulars of training and experience, P5823, The Engineer Office. P5823 A

INDIA.—WANTED for India, an ENGINEER SALESMAN, age 30 to 35; good prospects for energetic man; experience in India essential. State age, training, experience, and salary required.—Address, 1881, The Engineer Office. 1881 A

SALES ENGINEER REQUIRED by London Firm of Coke Oven Engineers and Contractors. Preferably 30-35 years of age.—Write, stating age, experience, and salary required, to Box Z.B. 219, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C.3. 1868 A

YOUNG ENGINEER, with Surveying Experience, REQUIRED for outside work on Transmission Line Construction.—Address, giving particulars of experience, &c., P5809, The Engineer Office. P5809 A

WANTED, a DRAUGHTSMAN, Experienced in Hydraulic Machinery.—Apply by letter only, stating age, experience and rate of pay required, to THE HYDRAULIC ENGINEERING CO., Ltd., Chester. 1765 A

SITUATIONS OPEN (continued)

WANTED by London Firm of Structural Engineers, TWO JUNIOR DETAILING DRAUGHTSMEN. State age, experience, and salary required.—Address, 1818, The Engineer Office. 1818 A

WANTED, SENIOR DRAUGHTSMAN, Thoroughly experienced in design and layout of Asphalt and Tarmacadam Machinery, Stonebreaking and Gravel Plants, Concrete Mixers, &c. Must be possessed of initiative and capable of carrying contracts through to completion with minimum supervision. State age, experience, and salary required.—Address, 1822, The Engineer Office. 1822 A

WANTED, Smart JUNIOR DRAUGHTSMAN, Preferably with experience in Centrifugal Pumps, for works in the South of England.—Address, giving full particulars of experience and salary required, 1865, The Engineer Office. 1865 A

CHIEF DRAUGHTSMAN REQUIRED for Large Firm of Bridge and Constructional Engineers in the Midlands. Must have had considerable experience in the design of Bridge Structures and the supervision of the preparation of competitive designs for Steel Buildings of all kinds. Personality and ability to control large staff of draughtsmen essential. A good position is available to a man of exceptional ability.

Address full particulars of age, qualifications, experience, and salary required, P5802, The Engineer Office. P5802 A

DRAUGHTSMEN, Capable Young, REQUIRED for Aircraft Detail Design Work. Must be quick and accurate.—Write, giving age, experience, and salary required, to HANDLEY PAGE, Ltd., Cricklewood, N.W. 2. 1859 A

DRAUGHTSMAN, Mechanical-Electrical, Experienced in Design of Large A.C. Machines. Full particulars of experience, age, and salary required.—Address, 1759, The Engineer Office. 1759 A

DRAUGHTSMAN.—Quick JUNIOR WANTED for Chemical and Structural Engineers, Westminster. State salary and experience.—Address, 1841, The Engineer Office. 1841 A

DRAUGHTSMAN.—REQUIRED in London Office of Firm of Engineers, DRAUGHTSMAN with knowledge of Conveying and Mechanical Handling Plants. Experienced men only need apply. State age, salary, and experience.—Address, 1826, The Engineer Office. 1826 A

DRAUGHTSMAN REQUIRED in General Engineer's Office in London. Must be able to design, take measurements and prepare working drawings. State age, salary, and experience.—Address, P5816, The Engineer Office. P5816 A

DRAUGHTSMAN REQUIRED, with Experience of Chemical Plant and Lead Work Construction.—Apply by letter, stating age, experience, and salary required, to THE NATIONAL SMELTING CO., Ltd., Avonmouth, Bristol, marking envelope "Draughtsman." 1835 A

DRAUGHTSMAN REQUIRED, with Experience of Structural and General Mechanical Engineering.—Apply by letter, stating age, experience and salary required, to THE NATIONAL SMELTING CO., Ltd., Avonmouth, Bristol, marking envelope "Draughtsman." 1836 A

DRAUGHTSMAN REQUIRED, with Good Knowledge of Steel Bridge and Constructional Engineering Work. Full particulars of experience, age, and salary required.—Address, 1876, The Engineer Office. 1876 A

DRAUGHTSMAN, SENIOR, with First-class Experience of Steam Turbine Design and Details.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 1830 A

DRAUGHTSMAN WANTED by Large Engineering Firm in the City, with experience of Pipe Work Layout. Good technical qualifications essential.—Address, stating age, experience, and salary required, 1866, The Engineer Office. 1866 A

DRAUGHTSMAN WANTED for Plant and Machinery development. Only men with experience need apply. Give full experience, wages reqd.—S. SMITH and SONS, Cricklewood Works, N.W. 2. 1670 A

DRAUGHTSMEN WANTED, with Several Years' recent experience in the design of Heavy Passenger-carrying Motor Vehicles and Lorries.—Address by letter, giving full particulars of experience, age, and salary required, 1847, The Engineer Office. 1847 A

DRAUGHTSMAN, with Experience of Power Transformers.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 1684 A

DRAUGHTSMAN, with Expert Practical Knowledge, Surface and Underground Belt Conveyor Layout.—Address, stating age, experience, and salary, 1824, The Engineer Office. 1824 A

JUNIOR DRAUGHTSMAN REQUIRED for Heating Engineer's Office near Borough, S.E. State full particulars experience, salary.—Address, P5824, The Engineer Office. P5824 A

REQUIRED IMMEDIATELY for Large Iron and Steel Works in South Wales, a capable DRAUGHTSMAN, thoroughly accustomed to Steel Works Rolling Mills. Must be able to prepare schemes for a new mill layout, and later all necessary working drawings. None but men with first-class knowledge should apply. State age, experience, and salary required.—Address, 1869, The Engineer Office. 1869 A

REQUIRED, TWO First-class DRAUGHTSMEN, accustomed to the design of Water-tube Boilers and Steel Structures.

Applicants must have wide experience in this class of work, otherwise they will not be considered.

Address in the first instance, stating age, salary required, and experience, 1870, The Engineer Office. 1870 A

SENIOR JIG and TOOL DRAUGHTSMAN WANTED. Only those with first-class production experience need apply. State age and salary required.—Address, 1828, The Engineer Office. 1828 A

SITUATIONS OPEN (continued)

SEVERAL DRAUGHTSMEN REQUIRED for Glasgow office, experienced in Aerial Ropeways and Transporting Machinery and similar work. Give full details of experience, salary, &c.—Address, 1873, The Engineer Office. 1873 A

SEVERAL DRAUGHTSMEN REQUIRED for the Design of Oil Circuit Breakers. Previous experience in this class of work desirable, but not essential. Also SEVERAL DRAUGHTSMEN REQUIRED for Lay-out of High-tension and Low-tension Switchboards.—Apply, stating age, experience and salary required, to THE GENERAL ELECTRIC CO., Ltd., Witton, Birmingham. 1793 A

STRUCTURAL DRAUGHTSMEN REQUIRED for London office, experienced in detailing Steel-frame Structures for Buildings, &c.—Apply, stating experience, age, and salary required, to Messrs DORMAN, LONG and CO., Ltd., 4, Central-buildings, Westminster, S.W. 1. 1823 A

TRACER, for Engineer's Office in Westminster. State age, experience, and salary required.—Address, 1874, The Engineer Office. 1874 A

WANTED by Large Engineering Firm in North Midlands, FOREMAN "FITTER ERECTOR," thoroughly accustomed to production and shop erection of Asphalt and Tarmacadam Machinery, Stonebreaking and Gravel Plants, Concrete Mixers, &c. State age, experience, and wages required.—Address, 1821, The Engineer Office. 1821 A

CLERK (Lady, About 30) WANTED for Engineer's office in West London; competent bookkeeper. Good wages. Knowledge of engineering terms would be useful.—Apply, in own handwriting, Box 686, c/o Judd's, 47, Gresham-street, E.C. 1857 A

YOUNG COSTING CLERK REQUIRED for Contracting Engineers in London.—Write, stating age, experience, and wages required, to Box Z.A. 218, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 1867 A

SITUATIONS WANTED

A QUALIFIED ENGINEER and DESIGNER, possessing considerable inventive capacity, DESIRES POSITION. Exceptionally wide experience, used to intricate machinery. Experienced draughtsman; fluent French; age 38; highest references.—Address, P5821, The Engineer Office. P5821 B

A QUALIFIED MECHANICAL ENGINEER (38), 20 years' experience in power plants designing, erection and maintenance steam, internal combustion and electrical, at home and abroad, SEEKS POSITION. Good refs.—Address, P5808, The Engineer Office. P5808 B

CIVIL ENGINEER (24), B.Sc. Hons., M.E. San. I., passed A.M.I.C.E. exam., 2 yrs. experience on sewerage and sewage disposal works, REQUIRES POSITION with firm of Consulting Engineers in London.—Address, P5806, The Engineer Office. P5806 B

CIVIL ENGINEER (25), UNIVERSITY GRADUATE, EXPERIENCED IN DESIGN AND CONSTRUCTION OF EARTHWORK AND MASONRY FOR IRRIGATION AND LAND DRAINAGE, REQUIRES APPOINTMENT AT HOME OR ABROAD.—Address, P5820, The Engineer Office. P5820 B

COST and WORKS ACCOUNTANT (37) SEEKS suitable APPOINTMENT. Fifteen years' experience in works costs, including foundry, and capable of working to final figures. Accustomed control staff. Energetic worker. Highest references.—Address, P5817, The Engineer Office. P5817 B

ENGINEER DESIRES Permanent Progressive POST in British Isles, preferably but not necessarily with powdered fuel co. Indentured apprenticeship, 5 years' experience with coal, oil fuel, superheaters, recip. engines, Parsons and Curtiss turbines on liners of 20,000 tons, 2 years senior with Sulzer and B. and W. Diesels on liners of 10,000 tons. Sole charge refrig. mach. and usual electrical maintenance, also considerable building experience. Extra First Class B.O.T. with First Class Motor Endorsement, M.I. Mar. E., recent Stud. I.E.E., 28 years age.—Box J., Smith's, Promenade, Hendon, N.W. 4. 1850 B

ENGINEER MANAGER (37), Possessing Tact, Push and principle, OFFERS his SERVICES to an Industrial Concern; past 12 years in an executive appointment. Works trained with I.C. engine builders, sound and varied technical, practical and commercial experience, both mechanical and electrical. Competent to plan and supervise building construction, plant layout, maintenance and development. Specialised knowledge of Diesel type power plant, crushing and dressing allied to a chemical industry. Has designed and constructed special machines, mechanical classification and material handling devices, also developed new labour-saving processes. Experienced in the control of staff and labour, estimating and correspondence. Moderate salary required with good prospects.—Address, P5807, The Engineer Office. P5807 B

ENGINEER SEEKS POSITION as Works Manager or Production Superintendent, General Engineering or Batch Production; 17 years' executive position; first-class references; graduated through works, D.O., and foundry; excellent record, organisation and control.—Address, P5815, The Engineer Office. P5815 B

ENGINEER (29), SEEKS RESPONSIBLE POSITION; public school education, experienced workshops, D.O., assistant engineer, works extensions and maintenance.—B.M./LO24, London, W.C. 1. P5760 B

ESTIMATOR, SUPERVISOR, BUYER of Exceptional experience and proved ability, SEEKING similar POST offering opportunities, age 25, highest credentials, would like to negotiate with front-rank firm who could offer an opening for ambition—Address, P5804, The Engineer Office. P5804 B

MECHANICAL and ELECTRICAL ENGINEER (24), 5 years' training with railway co., 2 years drawing-office and testing dept., followed by several months' commercial experience as representative, SEEKS SITUATION, either home or abroad.—Address, P5817, The Engineer Office. P5817 B

MECHANICAL ENGINEER (25), Single, Public school, trained shops, D.O., 2 years' factory experience abroad, speaks French and Spanish, DESIRES ASSISTANT ENGINEER POST ABROAD.—Address, P5812, The Engineer Office. P5812 B

POWDERED FUEL.—ENGINEER, with Experience in research, design, detail and estimating branches, also experienced in all types of boilers, SEEKS POSITION.—Address, P5825, The Engineer Office. P5825 B

DRAUGHTSMAN, JUNIOR, with Good Tech. educ., DESIRES CHANGE; 7 years drawing-office, 2 years shops.—Address, P5810, The Engineer Office. P5810 B

MACHINERY, &c., WANTED

WANTED.

MODERN NO. 6 RUSTON

STEAM CRANE NAVVY.

FITTED 7/8 C. YD. BUCKET,
ALSO WITH DRAG LINE EQUIPMENT.
Address, 1880, The Engineer Office. 1880 F

WANTED, Second-hand HORIZONTAL STEAM ENGINE, good condition, 100 H.P.—Address, P5793, The Engineer Office. P5793 F

For continuation of Small Advertisements see page 4.

A Seven-Day Journal

The London County Council Tramways.

AT the beginning of the week the Highways Committee of the London County Council made public its estimates regarding the operation of the tramways under its control during the current financial year. Emboldened, doubtless, by the fact that the estimated deficiency on the working during the year 1928–29, will, when the accounts are finally completed, only be found to be £30,626, instead of, as originally anticipated, £103,529, the Committee ventures to predict that there will be a surplus on the working during the year 1929–1930. The total receipts are put at £4,387,900, and the gross expenses at £3,616,335, so that the surplus on revenue account that is hoped for is £771,565. The debt charges, less a deduction for excess of income over expenditure on other items, will amount to £730,666, so that a net estimated surplus of £40,899 is arrived at. We may say that for the nine years 1921 to 1929—ended March 31st in each case—the average annual deficit amounted to £170,255, the year 1923 alone showing a surplus, the amount being £232,327. In framing its estimates for the current year, the receipts per car mile are expected to be 14·851d., as compared with the revised estimate of 14·681d. for 1928–29, the increase being attributed to the improvement in rolling stock, which is being progressively carried out. Consequently, it is estimated that the passenger traffic revenue will exceed the revised estimate for 1928–29 by £5000, notwithstanding the fact that allowance has been made for the closing of the Victoria Embankment to Southampton-row subway, in order that the latter may be enlarged to allow of the passage of double-deck tramcars.

Street Noises.

LAST October it was announced that the Ministry of Transport and the Home Office were about to take steps to secure the reduction of noises emitted by street traffic. To that end the two departments summoned a Conference, presided over by Sir Henry Maybury, and consisting of representatives of the Ministry of Transport, the Home Office and other Government Departments, the police and local authorities and motoring and road transport organisations. The Conference has now issued its report. As we anticipated in a journal note in our issue of October 5th, great difficulty has been encountered in framing regulations to deal satisfactorily with certain important aspects of the subject. As regards the excessive use of horns, or the employment of horns having a strident and irritating note, the Conference, after much consideration, could only recommend that a regulation should be issued prohibiting the use on a motor car which is stationary on any highway of "any instrument for the purpose of giving audible warning, except when such use is necessary on the grounds of safety." The suggestion that "zones of silence" should be established within which the sounding of horns on any occasion should be prohibited could not be supported. On the question of a definition of stridency the Conference could come to no decision. It apparently looks to the National Physical Laboratory to come to its aid in this matter and to set up a standard to which manufacturers can conform. As regards excessive noise emitted by road vehicles otherwise than by their horns, the Conference recommends that no one shall be permitted to use "on any highway any motor car which, or any part or accessory of which, or the load of which, creates any excessive noise." A noise is to be deemed excessive if it is caused by the faulty construction, condition, lack of repair or adjustment of the car or the faulty packing or adjustment of the load, and if it is in excess of the noise ordinarily created by a car of a similar class.

Control of London Traffic.

ON Thursday of last week, May 2nd, the third reading was carried in the House of Commons of the London County Council (Co-ordination of Passenger Traffic) Bill and the sister measure promoted by the London Electric Railway Companies. On the motion for the third reading, Sir Henry Jackson said that of the 132 local authorities within the London traffic area only eleven opposed the L.C.C. Bill, and even that opposition, he thought, would soon disappear. Far-reaching benefits, he said, would accrue to the travelling public of Greater London if the powers sought in the Bills were granted to the promoters. Immediately on their passage it was intended to promote a Bill for the extension of the Piccadilly section of the London Electric Railway northwards from Finsbury Park. All existing fares and arrangements would be continued under the common management. The ultimate aim of the promoters was that throughout London there should be a perfectly uniform system of fares. Adequate compensation would be granted to any employee displaced as a consequence of the passage of the Bills, but it was not contemplated that the establishment of a common fund and a common management would result in the discharge of a single employee. The extension of the Piccadilly Tube northwards would be the beginning of a policy of Tube extension to other districts of London. Considerable opposition to the Bills continued to be expressed right up to the end, but ultimately the third readings were carried by 145 to 54 in the case of the L.C.C. Bill, and by 140 to 56 in the case of the London Electric Railway Companies' Bill.

British Submarine Design.

SOME months ago we reproduced from our Berlin contemporary *Schiffbau* an article by an anonymous writer who was extremely severe on British post-war submarine designs, which he roundly condemned as backward and inefficient. As we remarked at the time, these strictures were vitiated by the fact that the writer had no knowledge of the special functions for which our new submarines were designed. In a later issue of the same journal, Professor Oswald Flamm, a German naval architect, had an article on a new form of submarine hull which was, he maintained, much superior in stability to all existing forms. Both in this and the previous article, reference was made to a mysterious submarine being built for "a foreign Power," which, thanks to the new form of hull, had an extraordinarily powerful armament in proportion to its displacement. Inquiry satisfied us that no such submarine was under construction. In the latest issue of *Schiffbau*, Herr Walter Rasenack, a German naval constructor, who was for many years associated with the actual building of submarines at Danzig, deals very faithfully with the previous contributors, exposes many fallacies in their articles, and deprecates their immoderate criticism of foreign designs. "It is certain," he writes, "that in designing their boats British and American constructors have followed definite principles which determined the size and other characteristics, and of these principles we have no knowledge." Herr Rasenack dismisses the claims on behalf of the new form of hull as being purely theoretical, adding that no responsible constructor would adopt it until he had secured practical data based on model experiments.

The Central Electricity Board.

ELSEWHERE in this issue we refer to the first annual report issued by the Central Electricity Board, and covering the period from the setting up of the Board on March 1st, 1927, to December 31st, 1928. Perhaps the most interesting section of the report is that devoted to the technical details of the grid, which will consist of some 3000 miles of overhead lines operating at a pressure of 132,000 volts. As shown in our abstract of the report, the system differs from the systems of the Continent and the United States, which have been mainly developed to transmit large quantities of power over long distances from localised water power or brown coal areas. In Great Britain, however, the main object of the grid is to interconnect large power stations. Another interesting section of the report is that relating to wayleaves. The routes of the lines are largely determined by the configuration of the land, and deviations can only be made within small limits, and, generally speaking, at considerable cost. These factors have added considerably to the difficulties of the Board, whose settled policy is to reduce to a minimum any action which may spoil the amenities of the countryside and to meet as far as possible the reasonable wishes of individual landowners as to the exact position of the towers. The Board has welcomed representations and co-operation from the societies and local authorities concerned in the preservation of amenities, and it acknowledges the helpful and public spirit in which the majority of landowners have recognised the need for facilitating the Board's work, even when it has not been possible to make minor alterations which the owners desired. The Board recognises that individual undertakers may require additional supplies before the grid would reach them in the normal course of events, and to meet these cases the Board is exercising its powers to make temporary arrangements, and, where necessary, it is constructing portions of the grid in advance of the programme.

Hand Combination Telephones.

A SUBSTANTIAL order has been placed by the Post Office with a London manufacturing firm for a new type of telephone instrument which constitutes a reversion to an improved form of the hand combination type superseded twenty or thirty years ago by the pedestal type, now in general use. A considerable section of the public has constantly shown a preference for the earlier class of instrument, which is known by the Post Office as the micro-telephone. Hitherto it has proved less efficient than the pedestal instrument, but research work carried out by the Post Office has resulted in the development of a new type of transmitter, which when mounted in a micro-telephone apparatus secures and maintains the full talking efficiency of the standard pedestal instrument. The new transmitter receives the acoustic energy of the voice upon a light but rigidly constructed diaphragm having an elastic edge instead of upon the uniformly flexible diaphragm hitherto employed. The external form of the new apparatus closely follows a design recently produced by the American Telephone and Telegraph Company, and brought into service by the American Bell companies. The base and cradle of the instrument and its electrical circuit, however, depart widely from the American design, and are thought to embody points of superiority. The new instrument will be applicable both to the manual and automatic exchange systems, for all that is required to adapt it to the automatic system is the addition of a calling dial to a fitting provided in readiness for it on the base of the instrument.

The Pollution of Rivers.

ON the recommendation of its Water Pollution Research Board, the Department of Scientific and Industrial Research has decided, in co-operation with the Tees Conservancy Commission, to make a thorough biological and chemical survey of the river Tees. For the present a period of one year has been fixed, during which time the department will meet the costs. The object of the survey to be undertaken is to gain scientific knowledge as to the natural behaviour of a river flowing through an industrial area. An endeavour will be made to find out how the river counteracts the effects of pollution, to determine its capacity for self-purification, and to ascertain generally the conditions which may help or hinder the natural process through which purification is effected. As the computation of the tide levels in various parts of the river is of considerable importance, the Admiralty has offered to place at the service of the Tees Conservancy Commissioners a large sized tide gauge, which should be very useful in carrying out the proposed pollution tests.

The Nile Water Regulation Agreement.

THE negotiations between the British and Egyptian Governments on the subject of the use and control of the Nile waters have ended in agreement, and on Tuesday last, May 7th, formal letters of acceptance were exchanged at Cairo between Lord Lloyd, the High Commissioner, and the Prime Minister of Egypt. The works covered by the agreement include the Aswan Dam, the already completed Makwar Barrage on the Blue Nile, the projected Lake Tana Barrage in Abyssinia, and the Gebel Aulia Dam on the White Nile, also a proposed canal through the Sudd region, and finally the projected dam at the outlet of the Albert Nyanza Lake. Under the new agreement both parties, it is understood, are free to construct works and apply measures for increasing their water supplies from the Nile, its tributaries, and lakes. In the case of works undertaken by the Sudan, provision is made for the protection of Egyptian interests, the agreement recognising, on the one hand, that the Sudan requires more water than at present for its development, and, on the other, that Egypt has natural and historical rights in the waters of the Nile. The Egyptian Government proposes to form a special department which will deal with irrigational affairs in the Anglo-Egyptian Sudan. The appointments to this department are to be made by the Egyptian Government, and it is understood that the first head of the department will be Mr. Arthur Deane Butcher, who at present is in charge of the hydraulic section in the Ministry of Public Works.

The New North German Lloyd Liners.

ON the recent occasion of the visit of representatives of the German Press to the new North German Lloyd liner "Bremen," now being fitted out at the Weser Shipyard at Bremen, Dipl-Ing. W. Koch, the technical director of the Lloyd Company, gave some further interesting details, both with respect to the ship and her propelling machinery. The length of the hull is about 933ft., with a beam of 100ft., and the height from the keel to the lowest part of the main deck amidships is 53ft. The "Bremen" has a measurement of about 46,000 gross tons, and she will be propelled by quadruple screw single-reduction geared turbine machinery. The exact output of the machinery was not given, but it is believed to be about 100,000 S.H.P. There are four turbine units, each comprising a high-pressure intermediate and low-pressure turbine, running at a designed speed of 1800 r.p.m., and driving the propeller shaft at 180 r.p.m., through single-reduction gearing. Two of the turbine units are placed in a forward engine-room, and two in an engine-room aft, separated by water-tight bulkheads from the forward engine-room. The two boiler-rooms are also quite separate from each other, and the boilers are of the high-pressure water-tube type. Most of the auxiliary machinery is electrically operated and four oil-electric generator sets of the airless injection type are accommodated in a separate auxiliary engine-room. The "Bremen" is expected to sail on her maiden voyage on Tuesday, July 16th, and she is due to call at Southampton the following day. Meanwhile, work is proceeding on the reconditioning and renewing of those parts of the "Europa" which were damaged in the recent Hamburg fire. Messrs. Blohm and Voss have now removed the damaged deck erections and some hull plates, while the funnels and fore mast have been unshipped. Good progress with the work of renewal is being made, and nothing, we understand, which exhibits the slightest signs of damage will be left in the ship.

The Shannon Power Scheme.

No. III.*

A GLANCE at the simplified diagram of connections—Fig. 23—and the main diagram—Fig. 24—showing the power station electrical connections in greater detail will reveal the fact that, when the Shannon power station is put into operation, apart from the house service circuits, three voltages will be in use. The alternators will generate current at 10·5 kV, the lines to the main feeding points of the network at Dublin and Cork will be operated at 110 kV, whilst the potential of the medium-pressure distribution system will be 38·5 kV. In order to ensure that, during the operation of the partial development scheme, the supply of energy to the 110 kV and 38 kV lines will be reliable

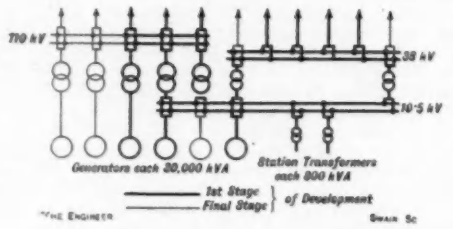


FIG. 23—GENERATOR CONNECTIONS

under all circumstances, it was decided to arrange that two generators should feed on to the 10·5-kV bus-bars, from which the 110-kV network will be supplied through two 30,000-kVA transformers, and the 38·5-kV network through two 8000-kVA transformers. The third alternator will feed through a 30,000-kVA transformer direct to the bus-bars, an arrangement planned for the final stage of development. In the diagram, Fig. 24, the double lines to Dublin are indicated at *a* and the line to Cork at *b*; *c* are quenching transformers, *d* reactances for generator protection, *e* high-speed switches for de-exciting the alternators, and *f* a water resistance.

The station services will be supplied by two transformers, each of 800 kVA, connected to the 10·5-kV bus-bars. Five lines—two ring mains and one radial feeder—will emanate from the 38·5-kV bus-bars, and three lines—one double and one single feeder—from the 110-kV bars. The whole of the lines will

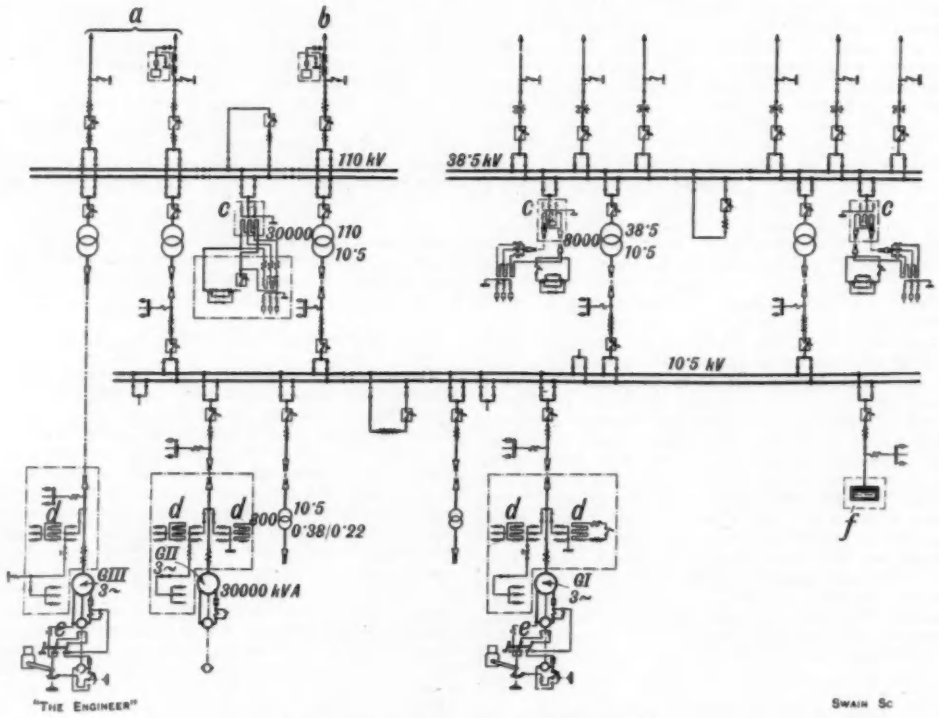


FIG. 24—POWER STATION CONNECTIONS

be protected against earth faults by quenching transformers and against short-circuits by impedance protection. As we explained in our last series of articles, in the final stage of development three additional alternators, each of 30,000-kVA, will be installed. They will be connected to the 110-kV bus-bars, whilst generator III. of the present installation will then be connected together with the other two to the 10·5-kV bus-bars. The final development stage also provides for two additional 110-kV lines protected against earth faults by quenching transformers. With a view to ensuring absolute reliability of the supply, the switchgear is designed on the double bus-bar principle, and links will enable different sections to be worked separately or to be coupled together as desired. It was decided to place the 110-kV switchgear outdoors, whilst the 10·5-kV and 38·5-kV gear is being erected indoors.

* No. II. appeared May 3rd.

The somewhat unusual ground plan of the switchgear shown in Fig. 25 is attributable to a desire to shorten the lengths of cables between the generators, 110-kV transformers and 10·5-kV bus-bars, and also to the situation of the lines emerging from the 38·5-kV switch-house. The 110-kV transformers are placed on the downstream side in the immediate vicinity of the machine-room, whilst the 10·5-kV switch-house is built on the upstream side, as an annex to the power station, as shown on page 462 of our issue of April 26th. It was necessary to place the outdoor station at a distance of some 560ft. from the

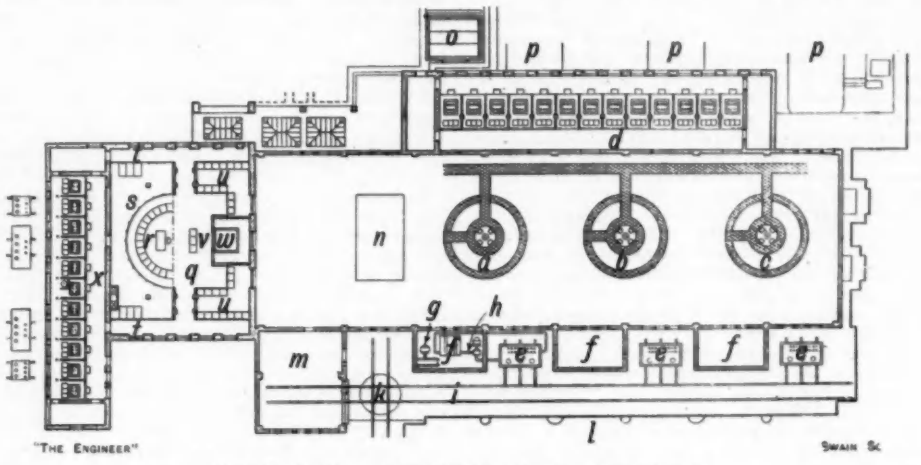


FIG. 25—PLAN OF TURBINE-ROOM AND SWITCHGEAR

building, but as the oil switches are remotely controlled and the disconnecting links are only likely to be opened at rare intervals, this is not a matter of great importance. In Fig. 25 *a b c* are the generators; *d*, the 10·5-kV switchgear; *e*, the 30,000-kVA transformers, with a ratio of 10·5/110 kV; *f* forced draught coolers; *g*, fans; *h*, an oil circulating pump; *i*, a rail track; *k*, a turntable; *l*, a channel to the oil shop *m*; *n*, the entrance to the cable subway; *o*, a water resistance; *p*, the turbine inlet pipes; *q*, the control-room; *r*, switch desks; *s*, the main switchboard; *t*, relay boards; *u*, the house service switchboard; *v*, desks for the signal installation; *w*, a lift; and *x*, the 38·5-kV switchgear.

As shown in Fig. 26, the indoor switchgear represents a combination of the cubicle and multi-storey principles, the oil switches being of the single tank suspension type. The room underneath the oil switches is completely sealed off from the adjoining rooms, but is open to the air, thus preventing the danger of smoke penetrating to other parts of the building. Concrete partitions separate the oil switches from each other in order to form a protection in case a switch should catch fire. Any oil that may escape in the event of such an occurrence flows off in ducts, and is collected in a tank. The end boxes of the incoming and outgoing cables are situated in the sub-basement. In addition to the oil switch tanks, the ground floor rooms accommodate the potential transformers for metering and synchronising, which are oil filled and arranged for suspension mounting similarly to the oil switches. On the high-tension side, the potential transformers are provided with series damping resistances, the current transformers being of the single conductor type. Owing to the high value of the possible short-circuit current in the 10·5-kV network, it will be necessary to employ oil switches rated at 2000 ampères. The 10·5-kV generator oil switches connected to the 10·5/110-kV transformers are also rated at 2000 ampères, and those for the 10·5/38·5-kV transformers for 600 ampères. The external appearance of the 10·5-kV and 38·5-kV switches is similar, and the whole of the switches will be operated from one gallery. In Fig. 26 the bus-bars are shown at *a*, the operating magnets for the oil switches at *b*, the isolating switches at *c*, the main oil switch at *d*, current transformers at *e*, and potential transformers at *f*.

The operating magnets will be placed along the cement wall, which will completely shut off the operating gallery from the high-tension gear. To the right and left there will be the operating handles and the pilot lamps of the isolating switches belonging to the respective circuits. This arrangement will enable an attendant who has received an instruction to draw one of the isolating switches to assure himself by glancing at the pilot lamp of the position of the oil switch before doing so, the isolating switches being operated by

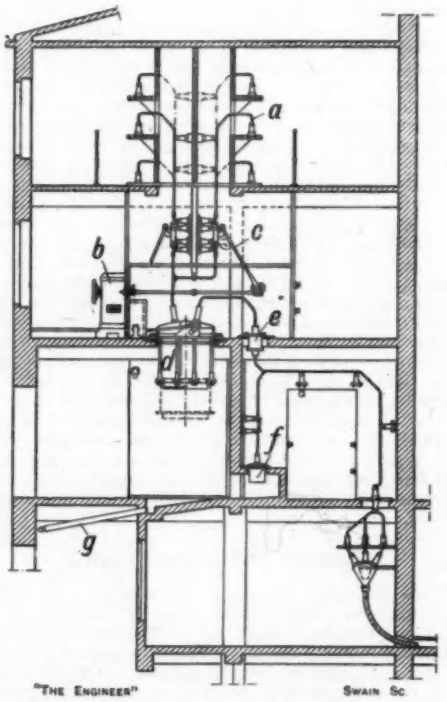


FIG. 26—10·5-kV INDOOR SWITCHGEAR

crank handles through worm gearing. As shown in Fig. 26, the duplicate bus-bars will be situated in the uppermost storey, each bus-bar consisting of three copper strips of 2½in. by ¼in. section. Undue strain on the supporting insulators, owing to expansion of the 105ft. bars when hot, will be avoided by the provision of flexible copper expanding pieces. As a protection against bus-bar short-circuits complete phase separation is being provided throughout. Not only will the bus-bars be separated by a partition, but screens, consisting of hard cement plates, will be inserted between the phases of each system. Besides the operating galleries for the oil switches, inspection galleries are being provided for the convenient supervision of all apparatus and conductors.

Danger lamps are also to be employed in the cubicles underneath the oil switches, and for the potential transformers. They will be controlled by switches in the immediate vicinity, but will only light up when the whole of the isolating switches of the respective circuit are open. For the purpose of carrying out load tests on the generators, a water resistance is connected to the 10·5-kV bus-bars. The 38·5-kV switch-house—see Fig. 27—is designed on similar lines to the 10·5-kV switch-house, and the oil switches, current and potential transformers and the regulating choking coils of the quenching apparatus are built into cubicles. In order to reduce building costs, the power and quenching transformers will be placed out of doors, beside the switch-house, as shown; whilst the cable-boxes will be placed in the sub-basement. On the floor above will be placed the

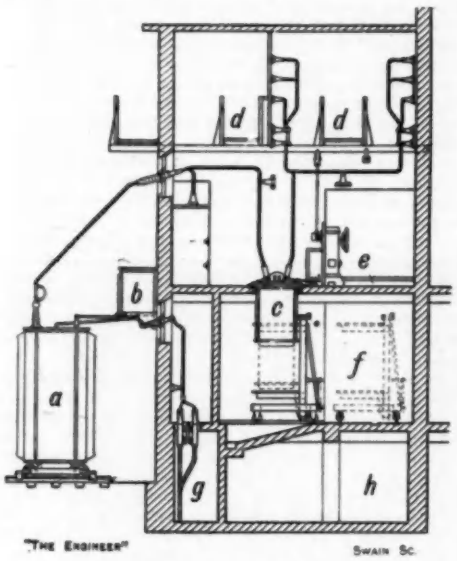


FIG. 27—38·5-kV SWITCHGEAR

exhaust chambers for the oil switches and behind them the oil-filled current transformers. Potential transformers will be connected to the low-tension side of the quenching transformers to measure the neutral voltages. All oil switches and isolating switches will be operated from a common gangway, and the earth switches for the lines will be interlocked with the isolating switches, so that it will be impossible to earth the lines until the isolating switches have been drawn. In Fig. 27, *a* is an 8000-kVA transformer; *b*, the expansion tank; *c*, the oil switch; *d*, a gallery; *e*, a duct for operating cables; *f*, a switch transport truck; *g*, a subway for power and lighting cables; and *h*, a subway for operating cables.

The whole of the oil and disconnecting switches associated with the 110-kV outdoor sub-station—see Fig. 28—are being erected on the ground level, and

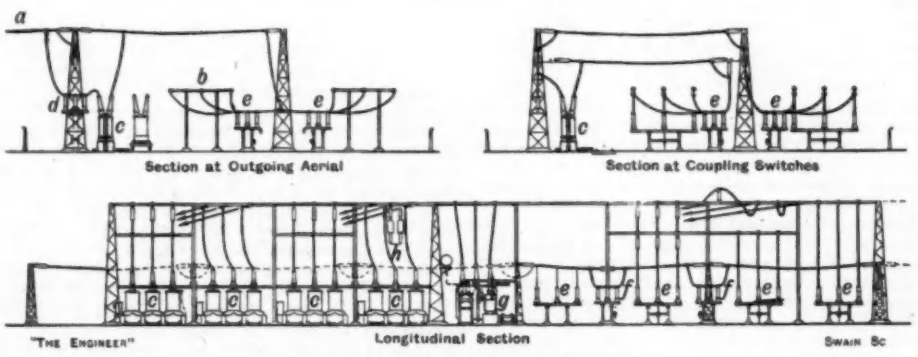


FIG. 28—110-kV OUTDOOR SUB-STATION

will be operated at that level. The leads from the transformers and the outgoing lines will be anchored to forty lattice poles. The duplicate bus-bars supported on 20ft. towers consist of stranded copper of 0·233 square inch section, and all the conductors are of stranded copper. In view of the particularly moist climate in Ireland, special care is being taken to coat all ironwork with waterproof paint, whilst parts of the ironwork that are inaccessible, owing to their being in close proximity to high-tension parts, are galvanised. The outdoor oil switches are composed of three tanks, and in view of the high-breaking capacity—1,000,000 kVA—the four breaking points per phase are accommodated in a separate tank. The bushings in the covers are designed to carry ring-type current transformers, and the whole of the instruments and relays on the 100-kV side will be connected to these current transformers.

The switches will be lifted from their pedestals by means of a hand winch on to a truck. Lifting magnets, of 865 foot-pounds capacity, will operate the oil switches. The isolating switches, which are of the three-pole single-pole rotary type, coupled together, are being mounted on 6·5ft. iron stanchions, and the operating gear will be brought down to a convenient height and will be actuated by cranks. The isolating switches are combined with earthing switches, with which they are mechanically interlocked. A quenching transformer set will serve as a protection against failure of the 110-kV supply in the event of earths. This set, which will consist of one quenching transformer, and two regulating choking coils, has been designed so that it may compensate the earth current of the whole 110-kV network in the initial stage of development. In the diagram—Fig. 28—*a* is one of the outgoing lines; *b*, bus-bars; *c*, oil switches; *d*, a line disconnecting switch; *e*, bus-bar isolating switches; *f*, bus-bar section switches; *g*, the quenching transformer; and *h*, apparatus for high-frequency telephony.

Apparatus, forming part of the 110-kV equipment, situated on the downstream side of the station, will consist of the three 30,000-kVA transformers, with a ratio of 10·5 kV to 110 kV. While these transformers are to be erected in the open, the coolers, fans, and oil circulating pumps are to be accommodated in buildings adjacent to the transformers, the star points of which will be connected through single-pole rotary disconnecting links to a neutral bar and will be earthed across a single-phase potential transformer. All the switchgear will be controlled from a single board. The necessary measuring instruments, control and pilot apparatus will be contained on a board consisting of sixty-six panels and nineteen desks. The main switchboard—Fig. 25—with the instruments for the 10·5-kV, 38·5-kV, and 110-kV plant, is arranged in a semi-circle; and a second concentric semi-circle formed by the desks contains a diagram of connections, which will enable the switchboard attendant to ascertain the position of all the switches at a glance, alterations in the position of any switch being announced by a signal. By manipulating the position indicators prior to giving the signal to operate the switches, the attendant can, by a survey of the illuminated diagram, convince himself of the correctness of the operation. As long as the diagram coincides with the actual state of the connections, it will remain dark, but when a change takes place in the connections at any point, the diagram will illuminated at the point in question, and will remain illuminated until the diagram is brought into register with the actual conditions. In the case of isolating switches, the position indicator will also serve as the signal transmitter. By turning the knob *a*—Fig. 29—the lamp *b* below will be made to light and to illuminate the glass dial *c*. On pressing the button *d* the signal lamp on the corresponding isolating switch will light up, and the press button will be held by a relay. In the event of the button springing back, however, the attendant will know that the lamp at the receiving end has not lit up, and that all is not in order. On the other hand, when the disconnecting link has been operated, the receiver lamp and pilot lamp on the diagram will be extinguished. The oil switches will be controlled in a corresponding manner, except that receiver lamps are unnecessary, as the switches will be operated by press buttons from the switch desk. Besides the cubicles for the station services, the room underneath the control board will contain a semi-circular iron scaffolding, with a gallery from which access will be obtained to the switch desks above. The shunt regulators for the exciters are also being placed in the basement, and will be operated by hand wheels on the front of the switch desks; but, generally speaking, hand regulation will be unnecessary, as the generators are being provided with automatic quick-acting voltage regulators.

Apart from the main switchboard and the desk, which will be in full view of the attendant when seated at his table, the control-room will also contain a 28-panel switchboard for the station services. Another 22-panel board will contain the whole of the relays for the various protective devices. The transformer connections are to be protected by overload relays with time lag. Protective devices will be inserted in the generator leads. The outgoing 38·5-kV lines are being provided with impedance protection gear, while the duplicate 110-kV Dublin line will have balanced feeder protection. The single 110-kV line to Cork will have excess current protection gear. A centralised system of signalling and danger signalling gear will inform the switchboard attendant of the operation of any of the protective apparatus. Three special desks equipped with illuminated indicators will show whether any of the line switches or earth relays have operated. All transformers are being equipped with danger signalling apparatus and Buchholz protection gear, the operation of which will also be rendered visible on the desks. The oil circulating indicators for the 30,000-kV transformers will be likewise connected. The operation of any of the foregoing protective devices will be announced on the table by the illumination of a sign, which will also indicate the apparatus in question. At the same time, an audible signal will be given. For testing the temperatures of all the transformers, a central measuring panel is being provided.

In the design of the switchboards particular care has been taken to avoid disturbing reflections, and to this end the boards are made of sheet metal, and the flanges of the flush pattern instruments are finished in dull black, in common with the housings of the relays. Care has also been taken to provide indirect illumination of the instrument scales.

Finally, the control-room is being equipped with two remote-reading water level indicators one for

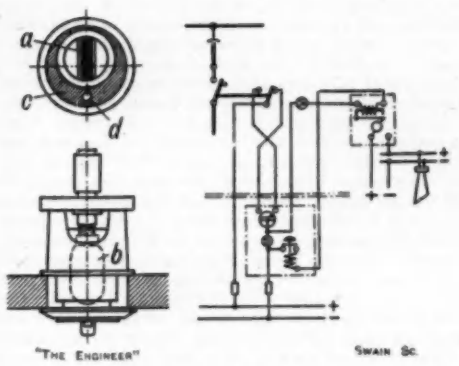


FIG. 29—POSITION INDICATOR

the upstream and downstream levels of the races. The control-room will be in communication with the more important parts of the station by automatic telephones, as well as with the more distant outposts, such as the outdoor station, water gate and dam. Whilst several of the telephone stations will be linked up to the public service, it will be possible to switch them over to the high-frequency line system, so that the chief engineer can at all times communicate with the switchboard attendants of the 110-kV transformer sub-stations.

In addition to the central control-rooms, the centre portion of the power station will comprise various offices, stores, &c., such as the battery and converter rooms and a repair shop. To meet the direct-current requirements, a battery of 114 cells having a capacity of 370 ampère-hours is being installed. A smaller 24-volt battery will feed the signal and telephone installations, whilst a third battery will supply current for the high-frequency telephone installation. Each battery will have its own charging converter.

(To be continued.)

Iron and Steel Institute.

No. I.

THE annual—and diamond jubilee—meeting of the Iron and Steel Institute was held at the Institution of Civil Engineers, Great George-street, London, on Thursday and Friday, May 2nd and 3rd. Mr. Benjamin Talbot, the retiring President, was in the chair at the opening of the meeting on May 3rd, when the usual formal business was transacted.

The annual report of the Council was taken as read and adopted.

Dr. H. C. H. Carpenter, F.R.S., Hon. Treasurer, in presenting the accounts for the past year, said that he was able for the first time in four years to record a credit balance, even though it was only a matter of £22. When, however, that was compared with the position four years ago, when there was a deficit of £879, he thought the Council was to be congratulated upon having taken steps to place the finances of the Institute upon a sounder footing. The principal item in which economy had been made was with regard to publications, a saving of £500 having been made under that heading without, however, detrimentally affecting the actual nature of the *Journal*. At the same time, it could not be said that the financial position was satisfactory so long as the income was so small as to compel the Council to restrict the work of the Institute in its most useful sphere, viz., the publication of technical and scientific papers or research work carried out under the direction of the various technical committees. The annual subscriptions, which were the chief source of income, unfortunately still showed a decrease, although a much smaller one than in the last four years. Dr. Carpenter expressed the

view that the Institute had touched low-water mark in that respect, because the income from entrance fees was substantially increasing, indicating that new members were coming forward. The membership had increased by 25 during the year and now stood at 2008, and it was hoped that by increasing the activities of the Institute by holding meetings in every centre, interest in the work of the Institute might be stimulated and new members from those districts attracted in increasing numbers.

The accounts were then adopted.

The President inducted his successor, Professor Henry Louis, into the presidential chair, and on the motion of Sir Peter Rylands, seconded by Mr. F. H. Harbord, a hearty vote of thanks was accorded to Mr. Talbot for his services as President during the past year.

Bessemer Medal.

Presenting the Bessemer Medal to Sir Charles Parsons, the new President said it was a curious coincidence and particularly appropriate that on the diamond jubilee of the Institute the highest distinction which the Institute had it in its power to award was conferred upon a man whose work had been connected with Newcastle-on-Tyne, seeing that the Institute was actually founded in that city. It was quite unnecessary on such an occasion as that to enumerate the very large number of services which Sir Charles Parsons had rendered to every branch of technology, services which covered everything from the manufacture of diamonds to that of steel ingots and from particles of microscopic dimensions to huge Atlantic liners. It was surely quite sufficient to say that there was hardly an ironworks of any importance in the country in which it was not possible to find some turbines or turbo-blowers at work. The brilliant work of Sir Charles Parsons had brought him many distinctions; indeed practically all the distinctions that a man in his profession might covet, but he ventured to think that, having regard to the long list of eminent men to whom the Bessemer Medal had been awarded in the past, even Sir Charles Parsons might take pride in adding his name to so distinguished a roll. Certainly the Institute was proud to have Sir Charles Parsons' name added to the list of Bessemer medallists.

Sir Charles Parsons, acknowledging the award of the medal, said he wished it to be associated with the name of Mr. H. M. Duncan, because Mr. Duncan had done most of the work in developing the new suggested process described in the paper to be read before the Institute. As a matter of fact, that process was an adaptation of an old method used ninety years ago by his father for casting large ingots of copper-tin alloy, specular, 6ft. diameter and 5in. thick. That was a chilling process, and it was thought that the application of that process to the steel might lead to some improvement in the manufacture of large ingots.

Professor Henry Louis then delivered his presidential address, of which an abridgment appeared in our last issue.

The "First Report on Blast-furnace Plant and Practice," by a Committee of the Institute—reprinted on page 523—was then presented by Mr. A. K. Reese, and was followed by a paper by Mr. E. H. Lewis entitled "Twenty Months of Dry Blast Operation." An abstract of the latter paper is as follows:—

DRY BLAST OPERATION.

In 1927 the author published the results of four months' work at the Wishaw blast-furnaces with air dried by means of a silica gel dehydration plant. He is now able to give more complete figures for the twenty months during which the plant has been in operation. They are collected together in a table.

The amount of moisture in the atmosphere in the "standard year" was previously given as 3·5 grains per cubic foot. This was the only figure then available, and was obtained from a station in the district. A comparison of subsequent records taken at Wishaw and at the same station showed that the Wishaw figure for 1925 should have been stated as 3·21 grains per cubic foot, and the table has been altered accordingly.

On three different occasions the moisture in the blast has been below 1 grain per cubic foot, and each time the burden had to be decreased to avoid "cold" iron. It appears, therefore, that 1 to 1½ grains per cubic foot is the best amount of "dryness" at which to aim.

Among other advantages of dry blast observed during the twenty months should be noticed the absence of "slips," the quick recovery of sticking furnaces, the improvement in quality of pitch due to the absence of slips, and the possibility of using a larger proportion of soft coal with a decreased proportion of coke.

The total quantity of water removed from the blast was 2373 tons, or 32 lb. per ton of iron.

At the conclusion of his paper, Mr. Lewis mentioned that the Wishaw plant had enabled a saving of £10,000 per annum to be made by the use of dry blast, notwithstanding that it was a small plant.

Mr. A. Hutchinson, opening the discussion, said that one of the outstanding features of the Report was the manner in which hearths were continuously increasing in size in the big American furnaces, and he began to wonder how much further that process could be carried. It seemed that it would be possible to build furnaces up to 1000 tons capacity and, in any case, at the moment, we had not apparently reached the limit. He congratulated Mr. Lewis on the successful results of his experiments with dry blast at Wishaw, which had shown that the method was well worth the serious consideration of anybody working under similar conditions.

Professor C. H. Desch asked Mr. Lewis if the silica gel in his system remained in good condition indefinitely. It seemed to him that there must be some difficulty in keeping out slight traces of tar, and some information from Mr. Lewis as to the necessity for renewing the charge of silica gel would be of value. It would also be interesting to know how far the dry blast system could be applied to blast-furnaces working under the usual English conditions, because it must be remembered that Mr. Lewis' furnaces were a little exceptional in that they were working largely with raw coal. Referring to the Report on blast-furnace plant and practice, Professor Desch said he had been struck, when visiting American works, by the very great importance attached to the grading of the size of the coke. At Pittsburg, for instance, where the coke was inferior to English blast-furnace coke in quality, considerable care was taken to reduce it to pieces about 2½in. cube, and anything below 1½in. cube was carefully screened out. The large outputs of certain American furnaces were attributed by the managers to a large extent to that very careful grading of the fuel. At Sheffield the question had been under consideration, and he regarded it as one of the most important points in the Report.

Mr. F. W. Harbord said he hoped that one of the points referred to by the Committee would be carried out, namely, that arrangements would be made for experts to investigate the particular problem or problems and report to the Institute in the event of any new development taking place, which, in the opinion of the Committee, required further investigation. As regarded Mr. Lewis' paper, Mr. Harbord said it was admitted by nearly all metallurgists that there were great advantages in having a dry blast, because not only was there a decreased fuel consumption, but, what was of importance, greater uniformity of product. It all came down to the question of cost, of course, and he believed that the old Gayley process had failed entirely on that score. It would add greatly to the value of the paper if the author could give some approximate figures, at all events, as to the capital cost of the plant per thousand cubic feet of air passed through. Ironmasters would then be able to strike a sort of balance and consider seriously how far the expenditure would be justified.

Mr. A. K. Reese, referring to Mr. Lewis' paper, said that for many years he had had the opportunity of working with dry blast on a coke furnace producing from 2000 to 2500 tons of pig iron per week, and the advantages were most marked as compared with natural air operation. With Mr. Harbord he agreed there was no reason why the advantages of dry blast in a coke furnace should not be as great as in a coal furnace. Indeed, they might even be greater. At Cardiff he, himself, was running furnaces continuously for long periods with a moisture content of well under 1 per cent. In fact, he aimed at 0·75, and it usually was between 0·75 and 1 per cent. He was inclined to question Mr. Lewis' explanation that the falling off in quality with low moisture was due to the catalytic effect of the moisture. It seemed incredible that under one grain of moisture would have that result. Generally it was possible to get plenty of combustion with under one grain of moisture. Did Mr. Lewis notice any increase in the rate of drive in his furnace during the period of the falling off of quality? In his own case he had found that the furnace drove faster with the same amount of blast when the moisture was low compared with the position when the moisture was normal in natural air, and if Mr. Lewis' furnaces were burdened for a moisture of 1¼ per cent. and it ran down to 0·75 per cent. it was possible that the furnaces might have driven very much faster. Any way, he felt that the explanation for the falling off in quality given by Mr. Lewis was not necessarily the correct one.

Mr. E. C. Evans, referring to the statement in the Report of the Blast-furnace Committee that 1 per cent. decrease in ash is equal to 2 per cent increase in the value of the coke, said the point was rather important and was a matter that was being considered by one of the Research Committees of the National Federation of Iron and Steel Manufacturers at the present time. If coke were taken at 17s. 6d. per ton, a decrease of 1 per cent. in the ash would, in accordance with the calculation in the Report, increase the value of the coke by 4d. per ton, and it had been shown by Mr. Gill at Consett, and others, that a 1 per cent. increase in ash would decrease the fuel consumption by something in the order of 0·4 cwt., which would be worth about 4d. per ton. That, however, took no account of the increased output, the saving in limestone, and other factors which were very important from the practical costing standpoint. As the iron and steel industry was a purchaser of coke and not a seller—except in a few cases—it was as well that it should get the fullest return for a decrease of ash content. Referring to Mr. Lewis' paper, Mr. Evans said that Mr. Lewis, by maintaining a constant moisture content in the blast, had eliminated a variable which was extremely difficult to ascertain in normal operation. Several British, continental and American critics had commented upon the equations put forward in the Bailey and Evans method and had suggested that those equations were not correct. When Mr. Bailey and himself, however, saw results indicating that the method was not correct, they immediately suspected the existence of another factor which was masked in ordinary practice, and Mr. Lewis' results had brought out one of those factors which he, at any rate, had never suspected before, namely, the variation in radiation in summer and in winter. It was clear that there was a definite difference in the amount of heat lost to atmosphere in Mr. Lewis' furnaces as between the hot months and the winter months, and it was interesting to know that Mr. Lewis had taken the rather heretical step of insulating the top portion of his furnace. As to the optimum dryness mentioned by Mr. Reese, the work that Professor Bone was doing for the National Federation of Iron and Steel Manufacturers promised to throw some interesting light on that subject. Professor Bone had already found that the reduction of moisture up to a point increased the rate of radiation and that below that point the rate of radiation was normally retarded, whilst with absolutely dry reducing gas probably no reducing effect took place at all. If those results were correct it would seem that below a certain degree of moisture the rate of combustion in the blast-furnace would be reduced with a consequent increase in fuel consumption.

Sir Frederick Mills said there was a hiatus of nearly half-a-century between the work done by Sir Lothian Bell and the work now being done by the Committee. It was surely very much better for a group of scientists to publish the difficulties than to leave the industry to find them out by rule of thumb. He would very much like the scientists to give a reason for some things which had been found out in practice; for instance, turbine blowing had almost completely done away with scaffolding in blast-furnaces. Was there any really satisfactory scientific reason for that? Again, nothing had as yet been said on the subject of excessive moisture in coke, but he was not at all sure that that was not almost entirely a question of regularity in the content of moisture, and it might be that, if further investigation in that direction were carried out, blast-furnace managers would be provided with an explanation of a more scientific character than was possible from rule-of-thumb methods.

Mr. T. H. Turner mentioned the question of machine castings and the greater uniformity of American machine-cast pig. A few years ago it seemed that this country was losing a market for pig iron on the eastern coast of the United States, because it was not supplying the uniform type of pig which the American foundries were supplying. This country did not seem to have followed that practice very rapidly as a whole.

Mr. Reese, replying to the discussion, said he believed it was a fact that in the United States foundrymen had adopted the machine-cast pig, although there were some who grumbled at it and wanted sand-cast pig. If, however, the makers of pig iron set to work to educate the foundrymen to use machine-cast pig, he believed it would be generally adopted. The trouble at present was that the output in many cases was not sufficiently large to warrant the introduction of the necessary machines and, moreover, with a small output, the cost did not compare very favourably with sand-cast pig. As regarded scaffolding, mentioned by Sir Frederick Mills, the difference referred to was probably rather due to the alteration and improvement in the lines of the furnaces that had accompanied the growing use of the turbo-blower. At the same time, the turbo-blower gave a more steady flow of air, and he would not like to say definitely whether that had any effect upon the scaffolding tendencies of the furnaces. The saving from the reduction of ash, mentioned by Mr. Evans, was obviously a matter of common sense, and Mr. Evans, of course, was right in what he had pointed out.

Mr. Lewis, replying to the discussion upon his paper, informed Professor Desch that the silica gel used in the Wishaw plant was as good after many months' operation as when first put into use. As a matter of fact, it had been found necessary to take a little of the gel out of the plant, as rather too much had been put in in the first place. A certain amount of tar certainly got through the plant, for there were large quantities of tar in the gas at Wishaw, and it was very difficult to eliminate the last traces. Activation took place direct with blast-furnace gas, but it had been found that the discoloration caused by the hydrocarbons deposited on the gel could easily be removed by raising the activating temperature by 10 deg. or 15 deg. He saw no reason why similar results should not be obtained on a coke furnace as on a coal furnace, except, of course, that on a coke furnace there would not be the oil that was obtained from the coal. As a matter of fact, that was something which was hoped for at Wishaw and was not expected in anything like the quantities actually obtained. He was unable to reply to Mr. Harbord on the question of cost of plant, as he was not now engaged at Wishaw. At the same time, he could go so far as to say that there was every prospect of the cost of the plant at Wishaw being wiped out in a very short time by the savings made. It was difficult to answer the question about optimum dryness, because Mr. Reese spoke first in percentages and then in grains, which made it difficult to follow exactly what he meant.

The final paper read on Thursday morning was one on "The A.I.B. Sinter Plant at Guest, Keen and Nettlefolds, Ltd., Cardiff Works," by Mr. W. E. Simons. An abstract of it is as follows:—

SINTER PLANT.

Although there are several sinter plants in Great Britain, the sintering of iron ores has not received the attention it deserves.

The evil effects of fine materials in the blast-furnace are too well known to be further elaborated upon here. The preparation of materials prior to their introduction into the blast-furnace is one of the outstanding features of modern American

and continental practice. F. H. Willcox* has stated that by crushing and screening ore, coke and limestone, it is possible to increase the output of a blast-furnace by about 12 per cent.

It is the practice at some continental plants not to put anything into the blast-furnace smaller than an inch cube. Besides higher outputs and lower fuel consumptions, less flue dust is made. Lower blast pressures can be used, less slipping and sticking occur, and more regular working of the blast-furnace is obtainable. The preparation of materials in Great Britain has been badly neglected. Very few plants have any crushing or screening plants.

Sinter itself is ideal for blast-furnace use, for it is very porous, with large surfaces exposed to the reducing gases, and is fairly fusible. Good sinter should be strong physically, porous, and free from fines. In appearance it is like hard boiler clinker, and is dark blue in colour.

The result of separating out the fine ores by screening and sintering at the Cardiff works has been the attainment of a consistently higher output, and coke consumption has been reduced by about 1 cwt., the amount of sinter used varying from 10 to 25 per cent. of the ore burden. In addition to separating out the fines, the lumpy ore and limestone are crushed to a uniform size.

Briefly, the operation of sintering consists of mixing fine iron ore, coke, and flue dust. This mixture is placed in a circular steel pan, and ignited by means of oil burners, a motor-driven fan drawing air through the pan. When burnt, the fine materials have fused into a dark blue clinker. The pan is then tipped, and the sinter is conveyed into a railway wagon ready for use.

The sinter house is 146ft. long, and the width from the centre lines of the roof columns is 40ft. 6in. Running the whole length of the building is a crane gantry, the span of which is 37ft. 6in. The height of the rails is 21ft. 9in. above the main floor level.

The sinter plant is a twelve-pan unit. The pans are placed in two rows of six each. At present only eight pans have been installed, and the remaining four are now being put in. Each pan is 2·6 m. (8ft. 6⅝in.) in diameter, 325 mm. (12¾in.) deep, and holds from 1·5 to 1·75 tons of finished sinter. It is made to fuse into a dense mass that sticks in the pans. Similarly, if there is too much carbon in the sinter material the mass melts and the resulting sinter is hard and dense and resembles mill cinder. It also tends to stick in the pans. The amount of carbon necessary in the sinter mixture varies with the materials under treatment. When sintering iron ore, pyrites, and flue dust about 7 per cent. of carbon is required. A small amount of anthracite or coke breeze is thrown on top of the pan prior to ignition. This ensures good ignition and reduces the amount of fines made to a minimum.

Flue dust is one of the most difficult materials to deal with. However, as a blast-furnace makes much of this material, it has to be used, and it is very cheap. Flue dust should never be used directly it comes from the blast-furnace. It has been found in practice that it sinters much better when it has been stocked out in the open and "weathered" for several months.

GENERAL VIEW OF THE INTERIOR OF THE SINTER HOUSE

of four ribbed circular steel castings, machined and bolted together.

Under the stands are the dust chambers, in which collects any dust which may be drawn through by the fan. The chambers consist of reinforced concrete boxes, from each of which a cast iron pipe conducts the gases to the fan.

The pan is then ignited by means of an ignition car, which runs on a track of 6ft. 4⅛in. gauge situated between the two rows of pans. The ignition car consists of a rectangular framework of mild steel sections riveted together and mounted on four wheels. On top of a king post fitted in the middle of this framework is fixed a beam, at one end of which the ignition apparatus is suspended, and at the other end is a cast iron balance weight. Between the ignition apparatus and the balance weight, the fuel oil tank is placed. The ignition car is driven by a 5 H.P. reversible motor, and by means of clutches either the car can be made to travel or the beam can be rotated.

The ignition apparatus itself consists of a circular hood, the inside diameter of which is the same as that of the pan. By means of a screw arrangement it can be lowered or raised. Around its circumference are three burners, equally spaced, which are so arranged that they can be oscillated in unison to ensure that the whole surface of the pan is covered by the flames.

The ignition is accomplished by means of fuel oil and compressed air at a pressure of 75 lb. per square inch. To ignite the pan the hood is first lowered over the pan. The compressed air hose is then connected to the supply. The compressed air cocks on the burners are always left open. The oil is then turned on at each burner and lit with a torch. To obtain a uniform ignition throughout, the burners are oscillated so that every portion of the pan is covered by the flames.

The time of ignition is from 1 min. to 2 min. When the ignition is completed, the oil is first turned off; the hood is then raised, the compressed air turned off, and the hose disconnected. The time of sintering is from 1 to 1½ hour, depending upon the materials being sintered. The oil consumption is 0·5 to 0·6 gallon per ton of finished sinter.

While the purpose of sintering is the agglomeration of fine materials, the process is greatly facilitated by the presence of a fair amount of small rubbly material, up to ½in. cube. Should the material be above this size, it is necessary to crush it, as it is too big to fuse into sinter.

All the coke breeze is crushed down to ¼in. cube. It is advantageous for the coke breeze to be rubbly, as otherwise it burns too quickly.

All the materials as they are delivered into the mixer are usually dry. Inside the mixer is a fine spray of water for wetting the material as it is mixed. The mixed materials should contain about 15 per cent. of water. This is necessary to keep the mixture open while it is being sintered in the pan.

All the materials should be free from lime. Lime and silica fuse together at a low temperature, which causes the materials

* *Iron Age*, 1928, Vol. CXXI., pages 1011–1012.

The President asked the meaning of the initials "A.I.B.," and it was explained that it is the name of the Swedish company which supplied the plant, viz., Allmana Ingeniors Byron, of Stockholm.

Mr. D. E. Roberts said that nothing was more important in blast-furnace practice than the dressing and sintering of materials. It was admitted that to put fine materials into a furnace was a mistake. There were two or three types of sintering machines, such as the old Lloyd and the Greenawalt. The one described in the paper was an improvement of the latter, which consisted of a series of rectangular pans in which the material was roasted and then tipped and emptied. The plant described by the author was circular in form, and the material was picked up and carried away to a separate building for cleaning, &c. The whole plant had been a great success and the study of sintering methods was well worth while.

Senor Luis Barreiro (Spain) said the paper would be of great interest in Spain, where some fine ores were found. The use of sintering methods encouraged the use of such fine ores.

Mr. F. W. Harbord congratulated the Institute upon having the details of the working of the plant at such an early date, given to it by one of its youngest members. Sintering was becoming more important every day in the iron and steel industry, as the difficulty of getting lump ore increased. The plant described in the paper appealed to him; the construction was on the ground floor. There was no heavy overhead construction or movable parts to get out of order. It was possible to put in a small plant of the type to sinter only the flue dust, but as the needs increased the plant could be extended without any heavy expense in superstructure. When he was in Sweden some time ago he had been told that the cost of such a sintering plant compared very favourably with other sintering plants having an equivalent output. He considered that the plant should receive serious consideration on the part of iron masters who were considering sintering their ores.

Mr. J. T. Tornblad criticised the A.I.B. plant in regard to some of its details. He thought that the charging method was crude and that there was risk of the pans burning. He did not approve of the material coming out all at once from the bunker into the pan, and asked for details of costs, including the electric power consumed.

Mr. Simons, replying to the discussion, said that the Cardiff plant had been put down with a guaranteed minimum output of 200 tons per day, and it had fully come up to expectations. The rate of ignition through the pan had been consistent and the pan did not burn, whilst the effect of all the material coming out at once from the bunker into the pan was in no way detrimental.

The annual dinner of the Institute was held in the Connaught Rooms on Thursday evening, May 2nd, with the President, Professor Henry Louis, in the chair. The toast of "The Institute" was proposed by Sir Philip Cunliffe-Lister (President of the Board of Trade) and acknowledged by the President, who said that one very obvious and simple way in which the Government could serve the great scientific institutions of the country was by rendering them free from income tax. The amount collected could make no appreciable difference to the Exchequer, but the loss of it checked the efforts of the institutions to carry on their great work of education and research. They were not profit-earning bodies; they did not work for individuals, but for general progress, and it would seem but natural that their funds should be free from income tax. The toast of "The Iron and Steel Industries" was proposed by Sir Henry Fowler and the response was made by Sir William Larke.

(To be continued.)

Roads and Road Transport.*

By Sir HENRY PERCY MAYBURY, G.B.E., K.C.M.G., C.B., M. Inst. C.E.

THE Council of the Institution came to the decision that it would not fail to be of interest to the members generally if the subject of "Roads and Road Transport" were taken this year for the James Forrest Lecture, and they were good enough to honour me by requesting that I should be the lecturer. The Council's wish is ever my pleasure.

It is well, occasionally, to pause and to take stock of the nature and value of development in any movement, and it seems particularly appropriate that, at the end of a decade after the termination of the Great War, we should turn to the subject of transportation on highways, having regard to the past history and the development that has taken place, and see, with such imagination as we possess, what are the prospects of the future.

HISTORICAL.

The history of the roads of this country is, of course, as old as the country itself. As in most other things, the roads as we know them to-day have developed from the original trackways which were made by our primitive ancestors to meet their day-to-day necessities.

Our knowledge includes the tracks formed by that Neolithic race which constructed Avebury and Stonehenge, to whose temples and meeting places located at these two central points many track converged.

In the light of recent knowledge there is no doubt that ancient British trackways radiated from Stonehenge along several well-defined routes, east to Sussex and Kent, south to Dorset and Hampshire, north to the Wash and the Norfolk coast, and along the Cotswolds, and west to the Mendips and the Severn Estuary. Another series radiated from the London which the Britons had founded on the banks of the Thames. Though some are to-day matters of conjecture, yet there is evidence of routes which ran to Canterbury, Colchester, Norfolk, York, and west along the Berkshire downs to the Temple at Avebury.

Many of the ancient trackways were adopted by the Romans in their initial military occupation, as, for example, the London-Colchester Road. Under that occupation there was developed the first organised creation of a road system to serve the country as a whole. The Roman occupation passed, and with its recession nearly the whole of the Roman road system fell into decay. A road once formed is, however, a most difficult feature to erase from the landscape, and a fair record exists of their labours. The civil disturbances, together with the ignorance and misunderstandings peculiar to the Dark Ages, reduced road communications to the roughest and most primitive condition. Out of this slowly and painfully emerged a new road system, inadequate, indirect, and ill-maintained, ill-adapted even to the requirements of to-day.

In time there slowly emerged a system of public highways, which, though extensive in character, were nevertheless governed by no general policy. Construction was primitive, and the results from the users' standpoint spoke volumes for their patience and toleration. With the stage coach era a bigger view began to be taken, and, as so frequently occurs, the necessity brought forth the man. William Murdoch, James Loudon Macadam, and Thomas Telford, each contributed his quota, and under them grew up the beginnings of the science of highway engineering.

Such were the conditions at the commencement of the railway era, beginning with the opening of the Stockton and Darlington line in 1825. This new form of locomotion commended itself so much to the public and to investors that capital was freely subscribed, and construction advanced at so great a rate that, in 1848, the last long-distance stage coach was run off the road, this being the "Bedford Times," which operated between the Swan Hotel, Bedford, and the George and Blue Boar, London, doing the journey, including stops, at 10½ miles per hour.

From the railway era until about the year 1878 the highways of the country did not excite more than

* The Institution of Civil Engineers. The thirty-fifth James Forrest Lecture, May 7th, 1929.—Abridged.

local interest, save that during that period various Acts of Parliament were passed, legalising the use of large locomotive engines in connection with agriculture, and with the haulage of materials required for commercial development.

The roads at that time were under the control of Highway Boards, the area of whose responsibilities was determined by the grouping of a series of parishes. Grants were made from Government sources towards the cost of many local services including that of through roads. The amount of Government assistance to roads in that period was, however, quite negligible.

These through roads were described as main roads, and included many which, at one time or other, had been constructed by Turnpike Trustees. In most cases the Turnpike Trusts had proved a financial failure, the amount of money received from the passing of traffic being insufficient to maintain them upon an economic basis, with the result that many such Trusts had liquidated, and the roads had got into an extremely bad state of repair, many having already become a charge upon the local ratepayers.

In 1888 probably one of the most important local government measures was enacted, which brought into existence in England and Wales the bodies we know as County Councils, and, in the following year, a similar Act was passed creating like bodies in Scotland. There are sixty-two such bodies in England and Wales and thirty-three in Scotland.

The inauguration of County Councils, and the duties which the Act transferred to and imposed upon these new bodies, foreshadowed large expenditure, to meet which additional State assistance was provided in the form of Exchequer grants, the service of roads being assured of an annual payment of a sum equal to one-half of the cost of the maintenance, as certified in the year in which the Act was passed. The total cost of maintaining the then existing main roads of England and Wales was from £4,000,000 to £5,000,000 only per annum.

This cost was not materially increased until, in 1896, an Act of Parliament, known as the Locomotives on Highways Act, received the Royal Assent. The Act abolished the man with the red flag and gave the light locomotive—in which was included a motor car—the right to travel upon the highways at a speed not exceeding 14 miles an hour. This enfranchisement of the mechanically propelled vehicle, with comparative freedom from restrictions which had been imposed prior to that time, gave a substantial impetus to mechanical travel, but the low limit of speed which the Act aforementioned imposed militated against intensive development.

In 1903 an Act known as the Motor Car Act was passed, which enabled the legal speed of 14 miles an hour to be increased to 20, and required and enabled the appropriate Government Department to issue Orders governing the use and construction of heavy motor cars, defining their axle weight, form of wheel construction, speed, &c. &c. Mechanically propelled travel from that date forged ahead at a great rate, causing ever-increasing damage to what were very lightly and inadequately constructed roads, the traffic proving to be an intolerable nuisance by disseminating alternately dust and mud, to the discomfort and danger of every other form of traffic upon the highways.

Great complaints were made to the Government by the local governing authorities of the country of the ever-increasing cost of roads, and thus of the necessity for additional State assistance, and consequently, in 1909, an Act was passed known as the Development and Road Improvement Funds Act, which set up a Board known as the Road Board, and provided that body with funds from vehicle and petrol taxation which they were charged to administer and distribute to the local road authorities of the country towards the cost of abatement of dust and the improvement of the highways under their charge. This Act for the first time, brought a Government Department into being having some power to define what roads should be specially assisted, and what form the improvements should take.

The amount of money which special taxation of vehicles and petrol produced was quite small in the early years of the Board ; still, it sufficed to meet the commitments of the local authorities, because the Board was not empowered to make grants towards maintenance, and many of the local authorities were not prepared to launch out into what the Board defined to be improvements, and towards the cost of which they were authorised to contribute. From 1910 onwards, however, a very large amount of work was done upon the highway surfaces as they then existed in the abatement of the dust nuisance, and in making the surfaces more or less impervious.

It was soon obvious that direct State assistance could not be confined to improvement works alone, but must be extended to cover reasonable maintenance charges, and in 1913, as a result of a report of a Departmental Committee appointed by the Government to consider this aspect of affairs, the then Road Board was charged with the duty of classifying the roads of the country into three classes, the first and second of which would receive substantial grants towards the cost of maintenance.

Unfortunately, before the classification scheme was completed all operations had to be suspended owing to international troubles, and the progressive work of improvement upon the highways came to an end, with the result that in 1919 the road situation of Great Britain was very grave indeed. This state of things applied equally to every form of transport—railways, docks, canals, &c., as well as roads—and it became essential for the maintenance of the transport services that steps should be promptly taken, not only to effect the necessary improvement to the highways, but to devise means for providing additional funds to enable such works to be carried out.

Passing over the long years of the war period, which contributed nothing to the improvement of our roads, bequeathing only arrears of work and the overstress of war traffic, we really begin with the conditions as existing in early 1919. On all sides there was an intense longing and feverish activity to get back with the least delay and interruption to the industrial *status quo ante bellum*. Railways had been intensively used during the war years, and much of the rolling stock and *personnel* had been sent to France. In like manner docks, harbours, and roads had suffered, practically all plant of every description belonging to the road service, together with officers and men, having been sent overseas.

Development—Post War.

Considerable numbers of mechanically propelled vehicles which had been procured for war services were put upon the market by the Government Disposals Board, and were quickly purchased by traders and individuals, many of whom were desirous of commencing haulage businesses while the course was yet clear.

It was in such circumstances that the Government, in 1919, for the first time in its history, appointed a Minister of Transport, to whom, amongst other things, the duties and power of the Road Board, together with its officers and staff, were transferred. I had the honour of being charged by the Minister to report to him upon the road and road transport position, and to suggest how funds could best be raised to meet and improve the situation.

It was obvious that no further financial assistance could be expected from existing Government sources, and the only course to pursue, therefore, was to seek additional revenue from the ever-increasing number of mechanically propelled vehicles which were being introduced. Accordingly representatives of the owners of the several forms of transport were called together to consider the matter, the result being the appointment of a Departmental Committee upon which all road transport interests were represented, and on which I served as Chairman. We set out to devise a scheme which should, at the outset, produce at least 9¼ millions sterling per annum, and should expand as additional vehicles were added to the road transport fleet.

By an Act known as the Roads Act, passed in 1920, the report and recommendations of the Departmental Committee were given effect to, the classification of roads scheme was approved, and the Minister was empowered to make contributions from the fund derived from the taxation of mechanically propelled vehicles of a sum equal to 50 per cent. of the cost of the maintenance and improvement of first-class roads, 25 per cent. of the cost of second-class roads, and special grants—in the Minister's discretion—to the improvement of other roads, and to meet special and unexpected contingencies. It may, therefore, be assumed that whatever improvement has been effected in the condition of the roads of Great Britain has, in fact, been accomplished during the last eight or nine years, because, although, as stated, some improvement did take place as a result of the administration of the Road Board, that improvement was wholly nullified by the inevitable neglect which obtained from 1914 to 1918.

The classification of roads scheme, which had been interrupted so suddenly by the outbreak of war in 1914, was completed. For all practical purposes it may be taken that all the main and disturnpiked roads for which the County Council were originally responsible have in fact been classified under the Ministry of Transport classification scheme, either as first or second-class roads ; and in addition there are roads still maintained by the Urban and Rural District Councils which are not main roads, but which, notwithstanding, are classified under the classification scheme.

The total mileage of all roads in Great Britain is 178,914, of which are classified :—

	Miles.
Class I.	25,139
Class II.	15,686
Class III., or scheduled roads, which are now receiving grants of 25 per cent. of the cost of maintenance	55,053

making a total of 95,878 miles, or 53·6 per cent. of the total road mileage of Great Britain, towards the cost of which grants are made from the Road Fund.

I have already told you that when the classification of roads scheme was prepared and approved it was decided that grants should be made to the local authorities of 50 per cent. of the cost of the maintenance and improvement of first-class roads, and 25 per cent. of the like upon second-class roads. During the present financial year further concessions have been made to the Local Highway Authorities, and in this year of grace they will receive 60 per cent. of the cost of maintenance and improvement of first-class roads, 50 per cent. of second-class and 25 per cent. of scheduled roads. This additional concession will mean that the State, from the Road Fund, will be paying nearly half the cost of the maintenance of all the roads in Great Britain.

There are at the moment in the United Kingdom about 2000 local authorities elected by the ratepayers, and having responsibility for and the charge of the maintenance of roads, and all of whom are competent to receive grants from his Majesty's Road Fund.

It will, no doubt, be of interest to my hearers if at this stage I show for the years 1922 to 1929 the receipts into the Road Fund under the taxation of vehicles scheme, and the payments out of the fund to the local authorities and/or their contractors, in connection with the maintenance and improvement of roads and/or the construction of new roads.

The receipts paid into the Road Fund from motor taxation upon the schedule set out in the respective years were as follows :—

Table I.

Year ended March 31st.	Motor taxation receipts. £
1922	10,795,000
1923	11,772,043
1924	14,090,044
1925	15,563,044
1926	17,455,044
1927	17,373,190
1928	19,665,580
1929	22,073,231

In these years the amounts actually paid to the local authorities of the country and/or their contractors, in connection with the maintenance and improvement of roads and/or the construction of new roads were as follows :—

Table II.

Year ended March 31st.	Total payments. £
1922	10,171,078
1923	13,725,605
1924	13,358,272
1925	15,483,434
1926	16,988,161
1927	17,789,356
1928	19,812,807
1929	18,519,697

The work undertaken at the outset was mainly directed to overtaking the accumulated arrears of the war years and the restoration of the surface to a good and serviceable condition, and as in the years immediately preceding the war extensive experiments had been undertaken in the endeavour to ascertain the best kind of surfacing material to withstand the new traffic, it was possible to make use of all the information so obtained and collated, and so to secure the greatest efficiency for the money expended. It soon became evident, however, that new methods of treatment and a larger outlook were necessary to deal with the ever-increasing traffic in order to reduce congestion in the great towns, and to minimise or eliminate the dangerous conditions which existed at so many points in our old highway system. Thus was fostered the development of by-passes, enabling towns to be avoided, and of which 226 miles have already been constructed. This work proceeded simultaneously with the improvement of road junctions and other danger points, and the general reconditioning of narrow, tortuous but important highways by re-alignment, widening and regrading.

In the outer areas of London alone very many miles of important new roads have been constructed, and this condition is repeated in lesser form in or near all the great towns of the country. As will be seen from the following table, within the period under consideration nearly 2000 miles of new construction has been accomplished, the greater part of which is of an important character.

Table III.—*Expenditure on Highways and Bridges in Great Britain*, 1914–1926.

Year.	Mileage of highways.	Gross expenditure on roads. £	Motor vehicles licensed.	Population of Great Britain.
1914–15	176,993	18,138,000	322,000	40,055,000
1915–16	,,	14,310,000	345,000	39,437,000
1916–17	,,	12,211,000	277,000	39,007,000
1917–18	,,	12,525,000	189,000	38,836,000
1918–19	,,	13,602,000	271,000	40,247,000
1919–20	,,	26,630,000	551,000	42,111,000
1920–21	,,	43,048,000	816,000	42,769,000
1921–22	,,	49,328,000	942,000	43,062,000
1922–23	177,320	50,278,000	1,094,000	43,304,000
1923–24	177,680	50,696,000	1,289,000	43,628,000
1924–25	178,305	56,509,000	1,501,000	43,783,000
1925–26	178,361	59,145,000	1,698,000	43,964,000
1926–27	178,737	60,000,000	1,865,000	44,104,000
1927–28	178,914	(?) 61,000,000	(?) 2,000,000	—

The chief work to which your attention might be directed is the policy instituted, and in part accomplished, of the reconditioning of the trunk road system. The programme instituted in the year 1924, and now virtually completed, dealt with the most urgent sections, amounting to 500 miles, out of a total route length selected of 1917 miles.

When I say that this entailed the substantial reconstruction not only of the roads, but of the too frequently weak and worn-out bridges, at a total expenditure of £7,000,000, you will, I think, agree that the first steps have been taken in an orderly betterment of the nation's principal highways.

As the traffic increases more of these trunk roads will necessarily have to be enlarged and improved, and in order that you may have a picture of the number of road vehicles now licensed I give below a table show-

ing the classification of these and the increase which has taken place in the numbers from 1922 :—

TABLE IV.

	1922.	1927.	1928.
	No.	No.	No.
Cars taxed on horse-power	293,740	739,310	821,481
Cycles	352,340	518,867	516,306
Goods vehicles	158,856	281,272	301,121*
Motor hackneys	72,263	78,283	77,996
All motor vehicles—			
Excluding tramcars and trade licences	909,984	1,657,819	1,758,250
Including tramcars and trade licences	933,308	1,687,965	1,789,552
Horse-drawn vehicles	237,342	103,857	83,824

* Includes 2024 agricultural vans and lorries. In previous years these descriptions of vehicles were classified as road locomotives and tractors.

It is very significant that the improvement of the roads combined with more efficient vehicle construction, has resulted in reducing the normal horse-power of motor vehicles.

The total expenditure on highways in Great Britain in 1913–14 was approximately £18,000,000. In 1919, the beginning of the decade under review, it was £26,500,000, and for last year, 1928, approximately £60,000,000—the total expenditure over the period of ten years being approximately £518,000,000. These are big figures, but so is the volume of traffic for which the highway engineer has to provide.

TRANSPORT.

It has occurred to me that you may be interested to know how all this new transport on highways has affected the railway companies of the country.

In the first place, it should be noted that in 1919 the railways, for obvious reasons, were not in a position to meet the transport requirements of the country satisfactorily, with the result that road transport obtained a substantial hold upon traffic of all kinds, and, as it became popular and cheap, those who found it most convenient, as a means of both passenger and goods conveyance, having left the railways, have not easily been re-attracted to them.

Undoubtedly for short distances the public service vehicle, such as the motor-bus, can compete very successfully and economically with any form of rail transport, and for distances up to 20 or 30 miles the commercial goods vehicle can hold its own on an economic basis with the best railway travel. Public favour for the road transport vehicle has proved disconcerting to the railway companies. The motor car has accounted for a good many passengers who hitherto travelled first class on the railways. The motor-bus has proved a serious competitor for distances up to 20 or 30 miles for the third-class passenger whilst the commercial vehicle can, for something like the same distances, compete as regards cost, time, and convenience.

All over the world, wherever motor travel has attained any degree of magnitude, railways are finding the same state of affairs. It is common knowledge that in the United States the competition has been felt so keenly by the railway undertakings that Inter-State Commissions have been appointed to inquire into the position thus created. In our own country, railway dividends have been so reduced and stocks in consequence have fallen so alarmingly as to cause some feelings of anxiety, and it was not unexpected therefore that when the railway companies sought powers last year from Parliament to run their own vehicles on the highways these powers were readily granted, upon terms generally identical with those possessed by the owners of vehicles already licensed and running upon the highways. It is believed that considerable use will be made by the railway companies of these powers, and that they will, either by themselves or by working arrangements made with existing road transport companies, seek to co-ordinate their railway operations with those of the road in the best interests of trade and commerce.

Omnibus Traffic.—Probably if one subject more than another in connection with road transport is engaging attention in Great Britain at the moment it is that of omnibus traffic and long-distance motor coaching, which is not only competitive with the railways, but is in many cases highly competitive with the tramways, both municipal and company owned. As there is no really effective control, other than local licensing, upon the number of such vehicles which may be upon the highway, these vehicles are very frequently highly competitive with each other. The matter has become so acute that in the autumn of last year the Government set up a Royal Commission to inquire into the whole subject of road transport and to report thereon. This Commission is still sitting. Meantime many local authorities who have large sums of money invested in tramway or street car traffic are seeking powers from Parliament to enable them to establish motor omnibus services to operate both inside and outside their districts, and voluntary regional areas are being constituted by which inter-running arrangements are made possible from one large centre to another.

It is generally agreed throughout the country that it is high time there was some effective control exercised over all these competing services, and I have no doubt that eventually legislation will be enacted which will bring all these forms of public passenger travel under effective control, probably securing monopolies to authorities and companies, in return for which these bodies will be brought under appropriate public control in order that the public interest may be safeguarded.

London Traffic.—We have had a very costly object lesson in the great area which we describe as "the London Traffic Area." Until the end of 1924 it was possible for anyone having a motor omnibus which complied with the constructional requirements of the licensing authority to put it on the streets and to ply for hire whether there was any real necessity for such a vehicle or not. The position became so acute and the local authorities and companies who had invested in tramways or street cars were suffering such a diminution in their incomes that they found themselves in a serious financial position. Public opinion became so pronounced that in 1924 an Act of Parliament known as the London Traffic Act was passed. This Act gave the Minister of Transport power to declare certain streets congested, and to restrict the number of vehicles licensed to ply for hire upon them. It was the stated intention of Parliament to protect the tramways against unlimited and unnecessary competition, and the Act of Parliament aforementioned has, to some extent, achieved this end.

Whilst the omnibus is an economical and popular form of travel, its very popularity militates against its usefulness in large centres. In London there are upwards of 5000 omnibuses plying for hire, and in the last completed year they carried 1917 million people, sometimes at the expense of the main line and suburban railways and of the London tubes. As I have already stated, in many cases the omnibuses defeat their own usefulness, because their travel is so frequent and the headway between vehicles so short that the streets are unduly congested, with the result that the speed of all traffic is slowed down, causing considerable loss to the whole community. Moreover, the tendency in every big centre of population is for the people to live further and further away from their work. This means new areas being developed, and land which a short time ago was under cultivation is covered with new houses, the occupants of which need more and more facilities for travelling to and from the centre, and when this additional travel is added to the already congested streets it follows that a serious state of things has been created.

In the area which we call London there are carried each year upwards of 4000 million people upon railways, tubes, tramways, and omnibuses—a traffic which would appear to justify quite a large expenditure of money if every form of transport were managed in the best interests of the inhabitants of the area.

ROAD CONSTRUCTION AND MAINTENANCE.

I fear I have wearied you with all this detail, and yet I imagine you would like me to say something of the engineering method of construction and of the relative efficiency having regard to cost, of the different types of roadmaking material. It is essential to a proper understanding of the position to keep ever in mind the financial aspect of every operation. In my experience there is no type of engineering work where money can be spent more extravagantly than upon the construction and maintenance of roads and bridges.

You will not be surprised if I tell you that, in my view, there is no "best road surfacing material" for all purposes. Each case should be dealt with on its merits, having regard to subsoil, climate and rainfall, and last, but not least, to the volume and weight of traffic which may reasonably be expected to be upon the road in question. I have seen materials costing up to 20s. a super yard laid upon a highway where a fifth of such expenditure would have sufficed, and had the work been executed at the lower figure the life of the material laid might well have been from eight to ten years, without, in the interim, being any charge upon annual maintenance account. Having for many years had to deal with 2000 local authorities, charged and entrusted with the maintenance of highways, I have invariably impressed upon the responsible officers the importance of thinking in terms of pence per super yard, pointing out to them that every penny so expended represents, on a road 18ft. wide, something like £60 a mile. If this feature be kept well in view by the highway engineer then relative values will soon make themselves apparent.

In the foregoing I have endeavoured to show the magnitude to which roads and road transport and their associated interests have developed, largely within the last decade.

It has been computed conservatively that the value of all mechanically propelled vehicles now using the roads of Great Britain is not less than £1,000,000,000, whilst if a value be assigned to the highway system upon present-day replacement costs probably £2,000,000,000 would not be too high a figure to assess. And the end is not yet.

In these great industries have grown up and developed sources of employment of the first importance to a nation of manufacturers. In 1927 the motor manufacturing industry alone directly employed 257,000 persons and manufactured 209,000 vehicles in the account year. I mention these facts in order to endeavour to show that small standards and limited conceptions should not prevail in shaping the future of the country's highways, which, in its highest expression, is but the modern and scientific evolution of the ancient right and freedom of passage enjoyed by the King's subjects of every rank and station over the King's highway.

The Lock Gates of the Welland Ship Canal.

THE massive lock gates on the Welland Ship Canal, which is now rapidly nearing completion, are a source of no little interest to the visitor to Canada. In planning the locking arrangements for the canal the time element was the chief consideration faced by the engineers. In order to reduce the time spent by a ship in passing through the canal it was deemed desirable to keep the number of locks as small as possible, by making the lift of each as great as might be found to be practicable and advisable. It was also deemed desirable to have the lift of all the locks the same, in order to use the lockage water efficiently and to have the lock gates interchangeable.

The Welland Canal is 25 miles long from the shore of Lake Ontario to the shore of Lake Erie. From Port Weller, on Lake Ontario, to the foot of the Niagara escarpment, a distance of 6 miles, the canal traverses ground rising gently to an elevation of about 150ft. above the level of the lake. Within the next mile the ground rises steeply, some 190ft. higher, to the top of the escarpment, which is above the level of Lake Erie. The low water level of Lake Erie is 325·5ft. above the low water level of Lake Ontario, and the difference between the low and high water levels of Lake Erie is 12ft.

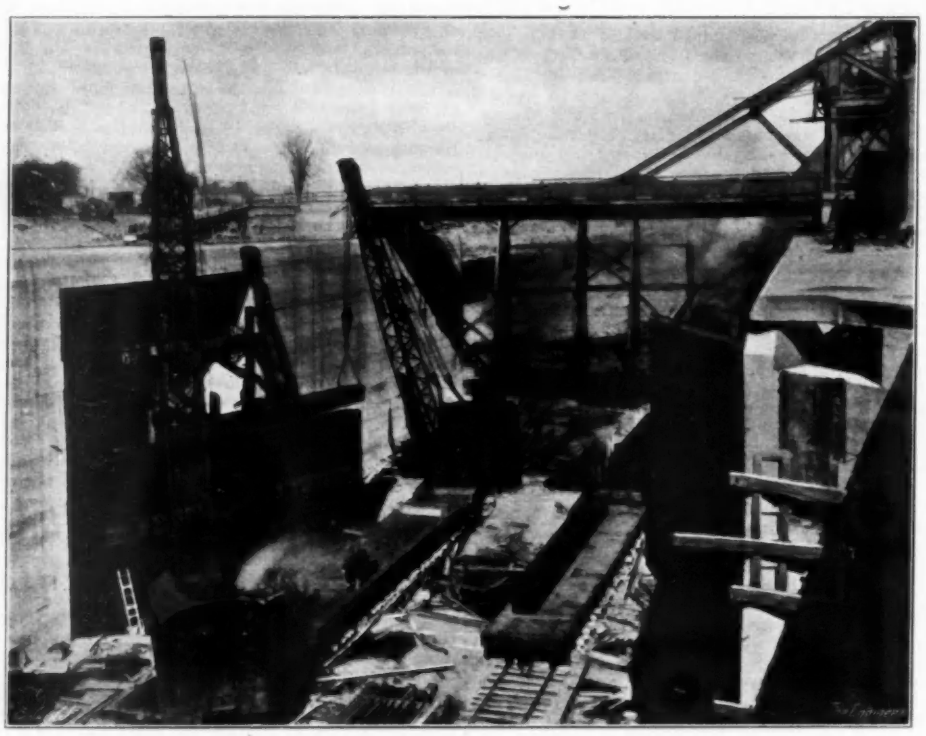
The adopted arrangement of locks provides seven locks of approximately 46·5ft. lift to overcome the total lift of 325·5ft. between the low water levels of the two lakes. These locks are 80ft. wide and have a usable length of 820ft. and a depth of 30ft. of water over the sill platforms. They are all situated near the northern end of the canal, between Port Weller and Thorold. In addition to them there is a guard lock at Port Colborne. The long summit level between Thorold and Port Colborne will be kept at or near the low water level of Lake Erie and the guard lock will be used to overcome the small variable lift between this level and the actual level of the lake. The guard lock is of the same width and has the same depth of water over the sill platforms as the other locks, but its usable length is 1355ft., the increased length having been adopted to expedite traffic by enabling two or more of the smaller ships to be locked through at the same time.

To suit the profiles of the surfaces of the ground and of the underlying rock the seven lift locks are arranged as follows :—Lock No. 1 is ¼ mile from the shore of Lake Ontario ; lock No. 2 is 1¾ miles from lock No. 1 ; and lock No. 3 is 2¾ miles from lock No. 2 ; locks Nos. 4, 5 and 6 are in flight, lock No. 4 being 1¼ miles from lock No. 3. The flight of three locks is ½ mile long, and lock No. 7 is ½ mile above lock No. 6. One mile above lock No. 7 a guard gate is provided to hold back the water in the long summit level in the event of the gates of lock No. 7 being carried away. The guard lock No. 8 at Port Colborne is 15½ miles above the guard gate. As the three locks Nos. 4, 5 and 6 in flight could not pass ships in both directions without serious delays to navigation, twin flights side by side are provided so that upbound ships can be passed through one flight and downbound ships through the other. Should the gates of locks Nos. 6, 7 or 8 be carried away, the canal works, under certain conditions, might be seriously damaged and navigation interrupted for a period of some months. In these locks, therefore, a guard gate is provided a short distance upstream from the service gate, both at the head and the foot of the lock, so that, in locking, at least two gates can always be kept closed, both of which would have to be carried away by a ship before free flow would be established through the lock. As a result of the doubling of the gates in lock No. 6, the plan area of its lockage prism is greater than that of either of the two locks in flight below it by the area of the space between the two gates at its lower end, and, since locks in flight are equalised by emptying one into the next below, the lift of locks No. 4 and 5 will be greater and the lift of lock No. 6 less than their average lift of 46·5ft. Locks Nos. 4 and 5 will each have a lift of 47·9ft. and lock No. 6 a lift of 43·7ft.

The locks must be unwatered from time to time for the purpose of inspecting, painting and repairing the underwater portions of the gates, valves, &c. In most cases this operation can be performed by draining the water from the reaches above and below the locks, but the reaches below lock No. 1 and above lock No. 8 cannot be drained, as they communicate with Lakes Ontario and Erie respectively. Also, the long summit level stretch between lock No. 8 and the guard gate cannot be drained conveniently, on account of the large volume of water it contains, or safely, because its banks in some places are in unstable material. Under these circumstances, to enable locks Nos. 1 and 8 to be unwatered by pumping, an unwatering gate in the reverse position is being provided at the lower end of each of these locks. An unwatering gate will also be erected above the upper guard gate of lock No. 8, to enable the upstream side of the latter to be unwatered for painting, &c. The unwatering gates will be of timber construction, so that they themselves will not require to have their underwater portions painted.

The upstream side of the guard gate can be unwatered by closing the emergency dam above it to hold back the summit level. The downstream side of

the guard gate and the upper gates of lock No. 7 can be unwatered by draining the reach between them. There is, however, some dockage on this reach, and it may therefore be inconvenient to drain the reach on some occasions when it may be desired to unwater lock No. 7 or the guard gate. Recesses, sills and supports are therefore being provided below the guard gate in which a spare gate can be temporarily set in the reverse position to enable the guard gate to be unwatered under such conditions. The upper guard gate and upper service gate of lock No. 7 can, if necessary, be used to unwater each other by transposing



LOCK NO. 8, ERECTING WEST LEAF OF UNWATERING GATES

them after one of them has been painted or by dry-docking the upper guard gate in the lock chamber.

TYPE OF GATES.

In deciding upon the type of gates most suitable for use on the canal all patterns were carefully considered, and, as a result, the form which swings about a vertical axis at one end was found to be the most suitable for the present purpose. In order to improve its speed of operation the toe quoin was placed some 22ft. upstream from the heel quoin, thus making its angle of rotation 15 deg. less than a right angle at the expense of an increase of only 3½ per cent. in the length of the leaf.

Work on the construction of the canal was begun in 1913 and was carried on, under the handicap of war conditions, until the spring of 1917, when all operations were stopped. In 1919 work was resumed under the direction of A. J. Grant, as engineer-in-charge, and he reopened the question as to the type of gates to be used. As no orders had been given for the lock gates, and as only a small portion of the work on the locks had been done, it was still practicable to change the type of gates. Mr. Grant recommended that double-leaf instead of single-leaf gates should be used throughout. The principal considerations leading to this decision were :—(*a*) The unprecedented size and weight of the single-leaf gate required ; (*b*) doubt as to the success of the dashpot device proposed for bringing the toe of the gate to rest in its quoin without shock ; (*c*) the unwieldy size of the floating crane required for handling single-leaf gates in replacements ; (*d*) the great expenditure of money and time that would be required in moving a badly damaged gate from the lock ; (*e*) the greater ease and speed of operation of double-leaf gates ; and (*f*) the probability that if equipped with safety horns their inferiority to single-leaf gates as regards safety would be to a large extent eliminated. Under the original scheme it was intended to use two gates at the head of each of the twin locks No. 6 and at the head of lock No. 8. With double-leaf gates it was decided, as an additional safety feature, to use two gates at the foot of each of the twin locks No. 6, at the head and foot of lock No. 7, and at the foot of lock No. 8 as well. It was also decided to use an unwatering gate at the head of lock No. 8 so as to enable the upper guard gate to be unwatered without moving it to another position, as was intended under the original scheme.

The estimated total cost of making these changes, including the cost of the necessary alterations to existing concrete work and the cost of the additional gates provided, less the saving due to the smaller number of spare gates required and the saving in the cost of the individual gates resulting from the use of the less expensive type, amounted to approximately 600,000 dollars. The increase in the usable length of the locks resulting from the change was 20ft.

GENERAL FEATURES.

Steel was adopted as the material of construction for the service gates and timber for the unwatering gates. The water load on the gates, 82ft. high, is so great that their construction in timber was found impracticable. For the gates 44ft. 6in. and 35ft. 6in. high timber could be used, but steel was preferred for the service gates for several reasons.

Five feet was chosen as the thickness of the gate leaves. A smaller dimension would have permitted the use of shallower recesses in the lock walls, but was considered undesirable for gates as high as 82ft. The gates 44ft. 6in. and 35ft. 6in. high could have been made thinner, but were kept of the same thickness as the high gates for the sake of uniformity. For the primary framework of the gates the horizontal system of framing was adopted for all of them.

ANGLE OF SILL.

It was desired to use timber bearings at the quoin and mitre for the gates 35ft. 6in. and 44ft. 6in. high on account of the greater ease with which a proper fit can be obtained with them as compared with metallic bearings. These gates are, however, close to the limiting size with which timber bearings are practicable, and it was therefore necessary to avoid unduly high reactions at the quoin and mitre. For the gates 82ft. high the use of timber bearings was out of the question, but there also, on account of the height of the lock walls, it was desirable to avoid unnecessarily high reactions at the quoin, as they will be quite high in any event because of the high head of water these gates will carry, viz., 78ft. at the flight locks. It was therefore desirable to use a fairly large angle for the sills of all the gates, and the angle the tangent of which is ½ was adopted.

As the weight of each leaf of the gates 82ft. high is close on 500 tons, it was important to give them as much buoyancy as possible in order to reduce the operating weight on the pintle. Furthermore, on account of their great height and relatively narrow thickness, great strength to resist buckling and twisting was essential. Double sheathing was therefore adopted for these gates as well as for the smaller ones.

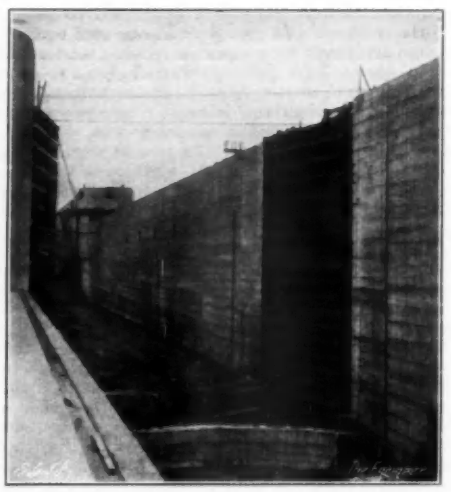
In one important instance a radical departure from previous practice has been made. Safety horns have been adopted for all except the unwatering gates. So far as is known, this feature has been previously used only on some of the gates of the present Welland Canal. The safety horns will permit one leaf of a gate to swing upstream about 4ft. from the mitred position before losing contact with the horns of the other leaf. In the case of the upper gate of a lock carrying an assumed head of 15ft. when struck by a ship, the work done in swinging one leaf against this head, and against the frictional resistance between it and the other leaf, through a distance of 4ft. at the mitre end, would be 1350 foot-tons. This is equivalent to the energy of a ship of 20,000-tons displacement moving at a speed of 2·08ft. per second. To move the lower gate of the lock the same distance, under its full head of 46·5ft., a 20,000-ton ship would have to have a velocity of 5·6ft. per second. These figures indicate that the safety horns will enable the gates to withstand a blow from a heavy ship moving at considerable speed.

Another unusual feature is the curved wall concentric with the pintle centre placed on the bottom of the recess for the gate in the lock floor under each leaf near its mitre end. The top of the wall comes about 4in. from the bottom of one of the jacking beams of the gate, and is reinforced with a grillage of three curved 12in. I-beams, so that should the anchorage be broken from any cause, the toe of the leaf will be caught on top of the wall. This will prevent the heel of the leaf from swinging clear of the hollow quoin, except when the leaf is near the open position, and therefore will probably save the leaf from falling to the bottom of the lock. The curved wall also acts as a guide for the wire ropes, which are used to operate the gate. By preventing the ropes from leading in straight lines from their anchorages to the gate leaf, the inequalities of their motion which would otherwise exist is rectified.

GENERAL DESCRIPTION STEEL LOCK GATES.

Each leaf consists of a series of plate girders placed horizontally one above the other between the vertical quoin and mitre posts of the leaf and connected to each other by vertical diaphragms and frames and the vertical intercostal beams which support the sheathing plates. Each leaf is enclosed on both sides from top to bottom and from end to end with steel sheathing plates riveted to the girders, vertical frames, intercostals and end posts. In order to reduce the cost of fabrication, special care was taken in working out the design to secure as much duplication as possible both in similar parts of the same leaf and in the corresponding parts of leaves of different heights. Only three different spacings of horizontal girders were used, viz., 5ft., 4ft. 6in. and 4ft., and the 4ft. spacing was used only in the high gates. The use of a closer spacing was avoided in order to keep the interior of the leaf accessible with reasonable ease. Each leaf has five lines of vertical frames spaced 8ft. 3in. centre to centre. A large manhold opening is provided through each frame in each panel of the leaf.

The lower part of the interior of each leaf constitutes the air chamber, from which water will at all times be excluded. The upper part, above the air chamber, forms the water chamber. Large openings are provided through the upstream sheathing plates, and through the webs of the girders in the water chamber, to permit the free entrance and exit of water so that the water level in this chamber will always be nearly the same as that of the water on the upstream side of the gate. There are vents in the upstream sheathing near the top girder to permit the passage of the displaced air. A manhole is provided in the top girder, in line with one of the water openings in the girders below and a ladder extends from the top to the bottom of the water chamber at this point to give access to the interior of the chamber for inspection, &c. Access to the air chamber is provided by means of a water-tight manshaft extending through



LOCKS NO. 5, LOWER GATES OF EAST CHAMBER

the water chamber from the top girder to the leaf to the top of the air chamber. There is a manhole opening in each girder in the air chamber opposite the manshaft, and the ladder in the manshaft is continued down to the bottom of the air chamber. The openings in the top girder for the manhole and manshaft are fitted with water-tight covers. To enable the air chamber to be ventilated when the leaf is unwatered for painting, &c., an opening with a removable water-tight cover is provided through the downstream sheathing in the bottom panel of the air chamber. The bottom of the air chamber will be covered with a layer of light weight concrete made with burned clay aggregate. The top surface of the concrete will be above the tops of the channel stiffeners of the bottom girder, and will be finished to slope from all directions toward a sump formed in the concrete vertically under the manshaft where a

small pump can be readily lowered into it for pumping out leakage water.

END BEARINGS.

For the gates 35ft. 6in. and 44ft. 6in. high, the end bearings consist of white oak timbers. Each bearing is formed of two timbers, the mitre bearing being flat and 21½in. wide. The quoin bearing is cylindrical of 20½in. radius and 25½in. wide measured on the chord. The hollow quoin bearings consist of iron castings embedded in the concrete of the rock walls and having concave bearing faces smoothly finished to a radius of 20½in. For the gates 82ft. high the bearing pressure is so heavy that timber bearings could not be used. For these gates the bearings consist of heavy wrought steel bearing pieces 8in. wide by 3½in. thick, supported in recesses in steel castings bolted to the ends of the leaf and bearing, at the quoin end, upon similar steel bearing pieces 12in. wide by 3½in. thick, supported in recesses in the steel quoin castings riveted to the structural steel quoin-bearing members, which are embedded in the concrete of the lock wall. The mitre-bearing faces are slightly convex of 16ft. radius. The quoin-bearing faces on the gate are convex of 18½in. radius, while on the lock wall they are concave of 20½in. radius. The bearing faces are accurately finished, and the bearing pieces are adjustable in their recesses in the castings, so that their finished faces can be set to a true straight line from the top to the bottom of the leaf, notwithstanding any slight inaccuracies there may be in the alignment of the castings after erection.

FENDERS.

Oak fenders are provided on the downstream side of the leaves to protect them in the open position from contact with ships entering and leaving the lock. When the leaf is in its recess, the surface of the steel work at its downstream side lies approximately 10in. back from the plane of the face of the lock wall, and the outer surface of the fenders lies about 1in. back from the same plane. Each leaf has a horizontal fender 13½in. wide, placed with its upper edge in line with the web of the top girder and extending over nearly the full length of the leaf. Below the horizontal fender are five lines of vertical fenders 11in. wide, placed on the lines of the five vertical frames and extending from the horizontal fender to a distance of about 15ft. below the level at which the surface of the water will normally be when the gate is open. At all points where the vertical fenders cross the horizontal girders they are supported laterally by a tapered oak block at each side, resting against a steel angle bracket riveted to the steel work of the leaf. To protect the footwalks of the gates 35ft. 6in. and 44ft. 6in. high from contact with the overhang of passing ships, these gates are provided with an additional horizontal fender placed above the top girder and supported by structural steel brackets riveted to its web plate. This fender is 13½in. high by 16in. wide, and its upper edge is placed 19in. above the web of the top girder.

When the leaf is in its recess its upstream side is about 12in. clear of the face of the concrete at the back of the recess, in order to facilitate the entrance of water behind the leaf as it moves out of its recess and reduce the force required to operate it. To hold the leaf clear of the concrete, under pressure from passing ships, horizontal oak timbers 14in. wide are bolted to the concrete in line with the two upper horizontal girders of the leaf, and with the alternate girders below them, down to a level near the lower ends of the vertical fenders on the downstream side of the leaf. The outer faces of these horizontal timbers are finished to fit the surface of the adjacent steel work of the leaf, the two inner rows of rivets in the girder flanges opposite the timbers being countersunk outside, and the corners of the timbers being chamfered to clear the heads of the next two rows of rivets.

OPERATING MACHINERY.

The lock gates will be operated by means of steel wire ropes. There will be two operating ropes for each lock gate leaf—one for opening it and one for closing it. The former will be attached to a U-bolt built into the masonry of the lock wall at the back of the lock gate recess, and the latter to a similar U-bolt built into the masonry of the lock gate sill near the centre of the lock, both U-bolts being slightly below the level of the bottom of the gate. From these anchorages the ropes will be led horizontally to a pair of sheaves—one for each rope—mounted upon the bottom of the lock gate leaf near the mitre end. Between the U-bolt anchorages and the gate leaf the ropes will lie against the face of the curved toe wall, which is concentric with the pintle centre. The sheaves on the bottom of the leaf are set in planes tangential to the face of the toe wall, so that the ropes will lead truly on to the sheaves from the wall in any position of the leaf. Near each end of the travel of the leaf, however, one of the ropes will lose its contact with the circular wall owing to the near approach of its sheave to the U-bolt anchor. This will cause the rope to deviate at a slight angle from the plane of the sheave, but the anchors are so arranged that this angle will in no case exceed 3 deg. From the sheaves on the bottom of the leaf the operating ropes will be led vertically up through the leaf to two sheaves mounted upon the top girder at the mitre end, and thence horizontally underneath the footwalk to a pair of sheaves at the quoin end of the leaf. From these sheaves the ropes will be led horizontally through a shallow slot formed in the top of the lock wall to the drums of the lock gate operating machine.

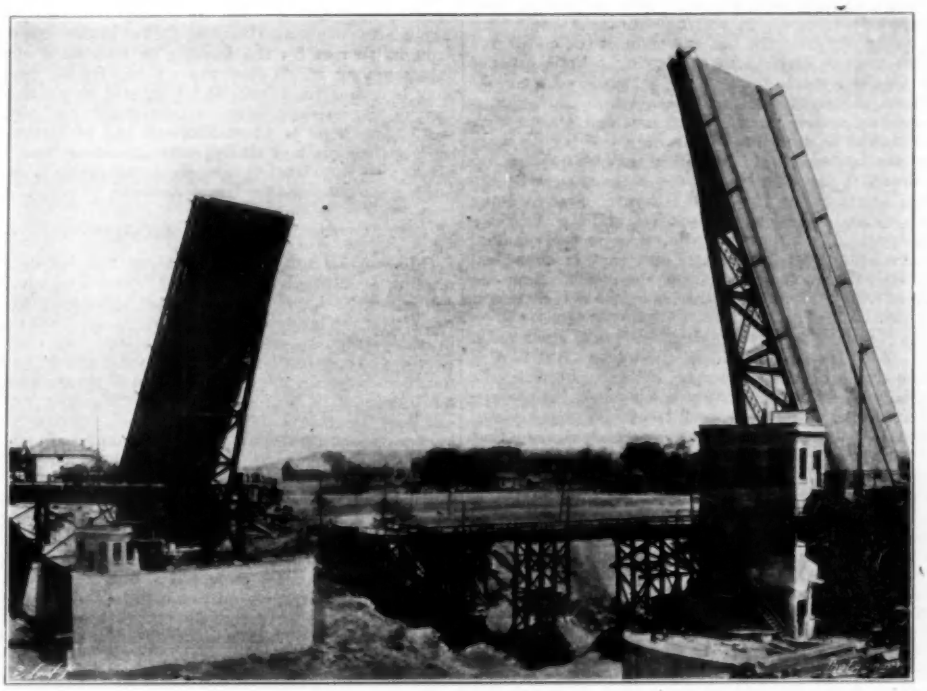
When the opening rope No. 1 is placed under tension by the operating machine, the part of the rope between the machine and the sheave near the quoin and the part between the sheave at the bottom of the leaf and the U-bolt anchorage, exert external forces on the leaf. The former force acts through or close to the pintle centre and produces no appreciable moment tending to rotate the leaf. The latter, however, acts at a radius of about 41ft. from the pintle centre and produces a large moment tending to rotate the leaf toward its open position. Similarly, tension in the closing rope No. 2 produces a large moment tending to rotate the leaf toward its closed position. One advantage of this arrangement of the operating ropes is that, as the leaf moves, the parts of the ropes between the U-bolt anchorages and the sheaves at the bottom of the leaf do not move toward or from the leaf, but the sheaves simply roll along the ropes. There is therefore no tendency for the ropes to be worked by rubbing on the underwater portions of the lock. Another advantage is that, for each leaf, only two sheaves are placed under water.

The operating machine is simply a large double drum winch driven by an electric motor through a train of spur gearing. A separate drum is used for each of the two operating ropes for the following reasons :—(1) To enable provision to be made for the slight variation in the relative travel of the two ropes by making one drum slightly larger than the other, and by permitting slight variations in the relative movement of the drums ; (2) to enable both ropes to be paid out simultaneously in the event of the gate leaf being carried away by a ship, thus preventing the machine from being subjected to the breaking load of the ropes, and incidentally to provide a convenient means for taking up slack due to the stretching of the ropes. The two main spur gears which drive the two drums mesh with each other and therefore have a uniform relative motion. The variation in the relative motion of the two drums is provided for by making each drum free to rotate, with reference to its driving gear, under the action of heavy springs acting against the pull of the rope, stops being provided to limit the relative movement of the drum and the gear to furnish a positive drive for the rope which is operating the gate leaf.

There is mounted upon each drum shaft the driving gear, a drive disc, the drum, and a spring spider, arranged in the order named. The drive disc and the spring spider are keyed to the shaft, but the drum and the gear are bronze bushed and made free to rotate upon the shaft. The driving torque is transmitted from the gear to the drum through the drive disc, which is connected to the main gear by means of a single pin in shear passing through holes in the adjacent rims of the two parts. This pin is designed to shear off and release the drum from the gear should the tension in the rope exceed 75,000 lb. In this way the machine is protected against excessive loads in an accident to the gate. There are six holes for the shear pin in the rim of the gear and twenty-five in the rim of the drive disc, thus providing for the adjustment of the relative position of the gear and the disc in steps of 0·84in. at the pitch of the rope. By means of this adjustment any considerable increase in the length of the rope, resulting from its stretching in service, can readily be taken up. In the rim of the drive disc, on the side adjacent to the drum, is cut a notch into which projects a heavy steel key dovetailed and bolted into the rim of the drum, the slot being so much larger than the key as to allow the drum to rotate through an angle of 25 deg. between the positions of contact of the key with either end of the notch. The other end of the drum overhangs the spring spider and three spiral springs mounted between the spider and the drum tend to cause the drum to rotate with reference to the spider in the direction which would wind in the rope. The rope is attached to the drum by means of a clamp bolted to the side of the rim. The clamp anchors the rope securely against a tangential pull, but will allow it to be ripped free from the clamp with comparative ease should the direction of pull have a considerable radial component, as would be the case in the event of all of the rope being unwound as a result of the lock gate being carried away by a ship. A slip friction is provided in the gear which meshes with the motor pinion. Its purpose is to prevent any part of the mechanism from being damaged should the gate meet unusually high resistance to its operation due to surges, wave action or the presence of some obstruction in the lock, or should the gate be moved by a head of water or by contact with a ship when the brake is set. Under normal conditions the operating machine will open or close the gate in 1½ minutes. The operating ropes are steel armoured wire ropes composed of six strands of nineteen wires each laid around a hemp centre, each strand being completely covered with an armour of flat steel tape wound around it before being laid up into the rope. The ropes are 1½in. in diameter over the armour and have an ultimate strength of 112,000 lb.

The motor is a 550-volt 3-phase totally enclosed wound-rotor induction machine with a split frame. Its nominal capacity is 45 H.P., and its synchronous speed, with 60-cycle current, is 600 r.p.m. The motor is equipped with a solenoid brake in order to stop the machine promptly when the gate leaf reaches the end of its travel.

The motor will be operated by a remote control from the lock control board, upon which there will be a control handle for each gate leaf. The control handle will have three positions—forward, off and reverse. It will be connected with the motor control panel, arranged close to the operating machine, by 220-volt control circuits. A control switch is also provided on the control panel to enable the motor to be controlled from that point when desired. The 550-volt power current to the motor will be controlled by magnetic contactors mounted upon the control panels. The motor will be started with resistance in three legs of the secondary circuit, a portion of which will be cut out automatically when the motor has attained the proper speed. The remainder will be left in the circuit to give the motor a slip of about 20 per cent. when it is exerting its full load torque. This is done in order to reduce the peak load by causing the gate to move more slowly under heavy load and thus reduce the hydraulic resistances to its motion. The forward and reverse contactors are interlocked so that both cannot be closed at the same time. An inverse time element overload relay and a low voltage protection relay are provided in each of two legs of the circuit which will open all three legs. Upon tripping, either of the relays will reset when the control



BRIDGE NO. 4 IN OPEN POSITION, LOOKING SOUTH-EAST

switch is placed in the off position. The overload relay will be so adjusted that should the gate leaf meet some obstruction in its course which will cause the slip friction to slip, the overload so produced will quickly open the relay and stop the motor. The motor is automatically stopped and the brake applied when the gate leaf reaches its open or its closed position, by means of a limit switch operated by direct connection to the heel of the leaf. The limit switch does this by opening the control circuit for the direction in which the gate has been moving, the control circuit for the other direction being opened at the other end of the travel of the leaf.

On page 518 and herewith are given several views of the locks and gates on the canal, which are reproduced from photographs taken in the early part of March this year. These views speak for themselves and require no detailed description. A view is also given of Bridge No. 4, in the open position, looking south-east.

Some Ideas about Metals.*

By Sir OLIVER LODGE, D.Sc., LL.D., F.R.S.

The usual electric current is a travel of electrons in one direction. There are two main kinds of conduction—first, when the electrons are free; secondly, when they are attached to movable atoms, so that they carry the atoms with them, which we may call chemical conduction. Conduction in liquids of electrolytes is wholly chemical, no electrons are free, their attachment to atoms is complete. There is no trace of metallic conduction in an electrolyte. Conversely, there is no trace of electrolytic conduction in a metal. There is no locomotion of the atoms with the current, the atoms are fixed. Metallic conduction must therefore be wholly due to free electrons—free, that is, either wholly and continuously, or temporarily and frequently by constant interchange between the atoms. Undoubtedly, electrons in a metal carry the current and constitute the only travellers. The atoms are jammed or crystallised into position, and constitute a scaffolding or framework through which the electrons pass. There is a friction between the gas atoms and the solid; so also there is a friction between the electrons and the atoms, and this friction we know is proportional to the first power of the velocity—for that is Ohm's law.

I have tried to apply this law, that the cling between atoms and electrons varies with the velocity, to the case of non-uniform temperature, so as to deduce the Thomson effect when there is a gradient of temperature down a metallic rod. Atoms, though fixed as regards locomotion, will be vibrating; they are vibrating faster at the hot end than at the cold. We might picture each atom as moving a little quicker on the down grade than on the up grade of temperature as it vibrates. The vibrations would exert a propelling action on the electrons, and the propulsion would be unsymmetrical when the temperature was not uniform. This would be easier to follow up in detail if the electric current were always in the same direction as the heat current. But in some metals it is in the reverse direction, and that makes a difficulty. We know that the effect is proportional to the absolute temperature, and that is all right; but it is rather surprising that the electric flow can just as well be opposed to the heat flow as concordant with it.

Consider what is known about electrical conduction first, and then about heat conduction. There is much similarity, and also some diversity between the two things. Electrical conduction is due to the passage of electrons, and the strength of the current will depend upon the density of the free electrons—that is, the number of them per cubic centimetre, and the speed at which they travel. Electron speeds are, indeed, great, but they may not be able to travel fast in any one direction through the interstices of the atoms. They travel exceedingly fast *in vacuo*, but in a gas they are much obstructed, and in a metal the obstruction must be excessive, so that what they lack in speed must be made up by number. The number of free electrons in a good conductor must be enormous, but, after all, it need not be so great as the number of atoms. It might be that each atom was responsible for one free electron; the total number would be then so great that their progress might be quite slow, even when a strong current is passing. But we now know—Rutherford has, indeed, shown experimentally—that atoms are by no means opaque to electrons. Only the nucleus is opaque; and that is so small that it is seldom hit. The rest of the atom is mostly empty space, and through it electrons can fly freely. One may fly through 10,000 atoms before striking a nucleus. In that case the free path, and therefore the mobility, is increased ten thousand-fold, and therefore a moderate number will suffice to convey a fairly strong current.

Electronic Inertia.

The question then arises, whether the free electrons ought to share in the heat energy. Energy might be received by a nucleus and stored away internally without being communicated to the planetary electrons, and still less to any free electrons there might be.

What are the arguments for a large number of free electrons? Well, one is based upon the conduction of heat and its close connection with electrical conduction. An insulator has no free electrons, and is usually a bad conductor of heat. Whereas a metal which is a good conductor of electricity is also a good conductor of heat; and, as is well known, the two conductivities are proportional to each other in a metal, the ratio between them being the same approximately for all the metals at the same temperature, the ratio itself varying directly with the absolute temperature. Electric conduction in a metal is due to the transmission or easy mobility of electrons. We may naturally assume that heat conduction is effected in the same way, and that when there is a gradient of temperature in a metal, the free electrons are streaming down that gradient of temperature and tending to equalise it. Just as would happen in an unequally heated gaseous enclosure, though in that case the equalisation is extremely rapid, unless the particles are obstructed by a porous substance. We need not suppose that the free electrons account for all the conduction of heat; but it would seem that they must account for the major part of it, the rest being done by the atoms. The crystallised atoms themselves would transmit the vibratory motion that we call heat, and in an insulator that is what they must be doing. Metals have this power, too; but they conduct so much better because the atomic transmission is supplemented by the free flow of electrons.

Is there no way of counting them? For, if we could could them, we should know their speed, and be much more informed about electrical conduction than we are. Well, it is clear that, although electrons are so light, yet if there are a sufficient number of them they must add appreciably to the weight and inertia of a body, and hence it might be that they would have mechanical effects, and that their presence could be mechanically detected.

It occurred to many people besides Clerk-Maxwell that the free electrons in a metal might be able to demonstrate their existence mechanically, and Hertz made experiments in that direction. More modern efforts have been rewarded with success. Tolman and Stewart spun a copper wire coil upon its axis, and then suddenly stopped it, as by a collision, hoping that by means of the spin even the free electrons would gradually get into circular motion, and that when the main framework of the metal was stopped the free electrons would continue for a time, and thereby produce a current which could be detected by a galvanometer. Of course, the effect is extremely small, the electrons are very light, have very little inertia, they are opposed by strong electric forces. Though free in a sense, they are almost instantaneously brought to rest by the friction or resistance of the atoms among which they move; but for an instant they overshot the mark, and they did give a deflection of the galvanometer—a remarkable and joyous fact. The hope of Clerk-Maxwell and of Hertz has by pertinacious and skilled experimenting been fulfilled, and the cloud of free electrons inside a metal has been mechanically demonstrated.

Conductivity of Some Alloys.

One way of missing a discovery—or, let us say, missing an observation of some interest, which may subsequently have a theoretical bearing—may be called the tendency to free interpolation. Everyone is on their guard against extrapolation, or pushing results beyond the field of observation; but we can hardly tabulate results at all unless we supposed that a fair amount of interpolation was legitimate. Everyone uses interpolation when they draw a curve through spots on a diagram which record actual measurements. But by that device we are apt to overlook unexpected and possibly important discontinuities, or singular features, such as would be represented in the diagram by rapid changes of curvature or by a zigzag line instead of a smooth curve. Not every physical curve is really a smooth one. There are many cases where smoothness is to be expected; but, especially in dealing with alloys, a slight change in chemical composition is liable to change the properties in a revolutionary manner. Those who are familiar with metals, as this audience is, know well what a great effect a trace of impurity or a slight change in chemical constitution may imply.

The conductivity of copper-tin alloys, the various bronzes, was examined by that excellent experimenter Mathiessen, and the results plotted as a continuous curve from pure copper, on the one side, to pure tin, on the other. But the intermediate portions of the curve were merely interpolated, observations being made chiefly near either end. Now it so happened that about half a century ago Sir William Roberts-Austen, of the Mint, making experiments on the conductivity of various metallic discs by means of Hughes's induction balance, obtained results with bronze discs in which certain bronzes of a brittle and unworkable character did not conform at all to Mathiessen's curve, though apparently they did conform to some severely criticised and discarded experiments by Messrs. Calvert and Johnson on the conductivity of these same alloys for heat.

Accordingly, Roberts-Austen cast some of these alloys into the form of rods about 1ft. long and ¼in. in diameter, and sent them to me at Professor Carey Foster's laboratory at University College, London, with the request that I would determine their specific resistance by Carey Foster's accurate Wheatstone bridge methods. I did so, and the results are published in the *Philosophical Magazine* for December, 1879. The middle part of the curve is entirely different from Mathiessen's; in fact, it can hardly be called a "curve" at all. The conductivity of pure copper is very great, six times as high as the scale of the diagram, as was no doubt previously known. The slightest trace of tin brings it down rapidly, as Mathiessen had observed, but the descent extends far beyond what he measured. It goes down to a sharp trough, where the conductivity is only twenty-millionths of a second per square centimetre, whereas pure tin is 80 of such units, and pure copper 610 of them. This alloy corresponds to the chemical formula $SnCu_4$, the proportion of tin being then 30 per cent. After that there is a rapid rise, so that when the proportion of tin is 40 per cent. the conductivity rises to 90 of the units, so as to be above pure tin. It then descends to about 70, when there is 80 per cent. of tin, and rises to 80 when the metal is all tin. The curve therefore contains a sharp trough and a shallower peak, each characteristic of some definite chemical composition in the alloy, and having the advantage that they once more unify the heat conductivity and the electric conductivity, which had seemed discordant from the simple smoothed-out or interpolated curve.

Superconductivity.

The splendid discovery made by Kammerlingh Onnes in his cryogenic laboratory at Leiden, that some few metals became perfect conductors at an excessively low temperature, must admittedly be of the first theoretical importance, and though it is difficult to suppose that any practical use can be made of this extraordinary and astonishing power, it would be rash to feel too assured even of that. It appears that the critical temperature at which this phenomenon suddenly makes its appearance, so that a metal ceases to have any electrical resistance, is for lead 7·3 deg. above absolute zero, for mercury 4·2 deg., and for tin 3 deg. Copper and other good conductors, I understand, do not show this effect, at any rate not yet. How are we to envisage the possibility of a metal offering no resistance to an electric current, so that an induced current, which usually dies out in a small fraction of a second, can last for hours or even days. It is said that a current in lead, for instance, only falls to half value in four days, which, as the late Lord Rayleigh claimed, was a fair approach to infinity. Why is the remaining resistance practically infinitesimal? Low temperature can hardly increase the number of free electrons. I can only suggest that the crystalline form of the metal then arranges itself in chains from one end of the rod to the other, leaving unobstructed interstices along which the electronic "gas" can move freely without encountering opposition, instead of being constantly checked and hampered by encountering the nuclei of atoms in its path.

It must be remembered that perpetual motion of this kind is characteristic of operations in really empty space; ether offers no resistance, and dissipates no energy, as long as things are moving without change of speed. Just as the planets move *in vacuo*, so every atom and every electron is moving in a vacuum. The only obstruction is made by encounters with matter—that is, with other atoms. In free space, an electron can go on for ever; and this is what the amperean currents which constitute magnetism are always doing. We do not really generate magnetism, we only open up a closed molecular loop in which an electron is circulating, and cause it to expand so as to surround a perceptible contour. I surmise that there is an ether flow, or, at any rate, a flow of some kind, along every magnetic line of force, for they are all closed curves. They have no termination, as electric lines of force have. I have looked for this flow, which is suggested by Larmor's theory, but have failed to find it. It must apparently be excessively slow, even in a strong magnetic field. If ever it is discovered, it will be by methods such as those of Kapitza for generating super-intense magnetic fields, as soon as these fields can be extended over a considerable region, instead of being concentrated in a small space. I do not expect to live to see it done, but I do perceive that when it is done we shall know a great deal more about the properties of ether and its constants than we do now.

* Nineteenth May Lecture to the Institute of Metals, delivered May 7th, 1929. Abridged from part of the lecture.

Present practice in the wood-preserving industry is to base specifications for preservative treatment on the net retention of preservative per cubic foot of wood. Experience in the impregnation of wood with either water solutions or preservative oils has shown that most timbers which contain heart-wood cannot be completely penetrated even by the most effective methods of treatment. Present specifications for the preservative treatment of wood do not give sufficient attention to the variability in results. Absorption by volume of timber is the most satisfactory and convenient method of specifying treatment provided it is based on a consideration of the ratio of the surface area to volume. The ratio of surface area to volume does not need consideration when an open, porous condition of the wood makes it possible to obtain practically complete penetration.

LAUNCH OF BOW SECTION OF 15,000-TON FLOATING DOCK

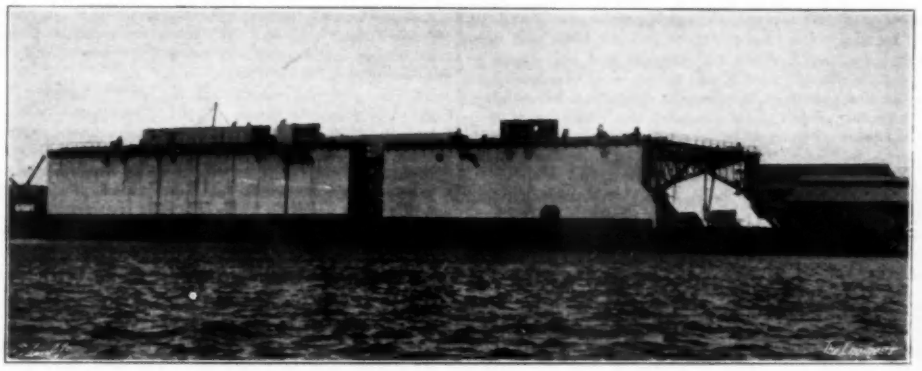
THE GOVERNMENT DOCKYARD AND ENGINEERING WORKS, WALSH ISLAND, ENGINEERS

An Australian-built Floating Dock.

We have this week received from Australia two views—reproduced herewith—of the floating dock which is at present under construction at the Government Dockyard and Engineering Works at Walsh Island, Newcastle, New South Wales. This dock is being built in three sections of approximately equal lengths—210ft.—two of which are now completed and launched. The first to be launched was the centre, or main, section, which was sent into the water on October 5th last year, the ceremony being performed by the Hon. T. R. Bavin, the prime minister of New South Wales. The second section to be completed was the bow portion, which was launched on March 15th last by Mrs. E. A. Buttenshaw, the wife of the Minister for Works and Railways. One of our illustrations shows this second launch, while the other shows the centre and bow units, which, ordinarily, will be coupled together to form one floating dock, and which will then be capable of docking vessels up to 11,000 tons, or, alternatively, the third section. In fact, any two of the sections will be able to lift the third. When the third section is completed, which, it is anticipated, will be in September next, it will ordinarily be used as a separate unit, suitable for the quick docking of smaller vessels up to, say, 4000 tons capacity. It will be possible, however, to couple it up to the two other units, so as to form a dock with a lifting capacity of 15,000 tons, which could accommodate the new Australian cruisers "Australia" and "Canberra," which are 630ft. long. The length overall of the third unit will be 212ft., and it will have a clear width at the entrance of 82ft., the depth of water over the keel blocks being 15ft. As a two-unit structure, the dock will have an overall length of 420ft., with the same width of the entrance—82ft.—but the depth of water over the keel blocks will be 26ft. With all three units coupled together, the overall length will be 630ft. Both the larger and the smaller units are self-contained, the electric energy for operating them being produced on board by Diesel-driven generators.

The dock, which is being constructed under the supervision of Mr. A. C. Waters, General Manager of the Walsh Island Dockyard and Engineering Works, must, under Naval agreement, be available for service anywhere, and will, therefore, be capable of being towed to sea in one length and moored in open water. Whilst at Walsh Island, however, it will be moored off the foreshore by three steel lattice beams, each 126ft. long, secured at their shore ends to anchorages of concrete.

While on this subject, a few words regarding the establishment at which this dock is being constructed may not be out of place. Walsh Island is situated on the Hunter River, about 2 miles from Newcastle, immediately opposite the Broken Hill Proprietary Company's Steel Works, and in the centre of the New South Wales Coalfields. The works now covers an area of 145 acres, and has a wharf frontage to the Southern Arms of the river of 2000ft. It was originally equipped for shipbuilding and ship-repairing in all its branches, bridge building and general engineering. It is, in fact, quite prepared, so we gather, to build ships even now, if it could get orders for them. Apparently, however, the wages paid are double those paid in other countries, while the hours worked are longer, so that, without protection, it cannot compete in price with overseas constructors. It has three slipways adequately furnished with cranes, and in the past has produced vessels up to 6000 tons deadweight. It furthermore has a mould loft with a floor space of 11,917 square feet, and is otherwise laid out for shipbuilding. The floating dock has, in fact, been built on one of the slipways. Owing, however, to slackness, which is due to the reason just mentioned, in the shipbuilding trade in Australia—there are, we understand, no ships under construction on that Continent at the present time—other outlets for its activities had to be sought for, and its output now includes steel cars for railway work, railway rolling stock, electrification work, welded steel pipes and cast iron pipes for all services. Some 2500 men are at present employed. It has a bridge yard 1100ft. long, with two 10-ton Goliath cranes running from end to end of it; a pattern shop which has a floor space of 18,100 square feet; a large foundry which extends to as much as 77,100 square feet; and iron castings up to 30 tons, steel castings up to 2 tons, and bronze castings also up to 2 tons can be undertaken. Cylinders measuring 84in. in diameter by 84in. stroke, have been produced, while marine engine cylinders, 68in. diameter by 45in. stroke, have been turned out. The largest-sized vessel which the yard has built up to now measured 331ft. in length by 47ft. 9in. in breadth and had a draught of 26ft. 1in., and a gross tonnage of 3359. Marine engines up to 2350 I.H.P. have been produced.



THE CENTRE AND BOW SECTIONS OF THE DOCK

It is planned to establish central stations at Stockholm for the joint heating of rooms and water in many houses, so as to save fuel and labour. A committee of five has been appointed by the municipal authorities to investigate the plan.

American Engineering News.

Inspecting Foundry Moulds.

In foundries producing castings of great variety it is not practicable to standardise practice in moulding, pouring and cleaning, as is done with advantage where large quantities of the same article are produced. A method of effecting economy in the former case, which has been introduced by the Newport News Shipbuilding Company, is to organise a planning department which not merely plans the flow of work through the foundry but also conducts periodical inspections of the moulds as they are made. A card issued with the order specifies at what stages of the work the foundry superintendent wishes to inspect the mould. This means that the foreman must notify the superintendent and not proceed with the work until the inspection has been made. This usually takes but a few minutes; approval is given or changes are ordered; the superintendent signs the card and the work proceeds. In some cases, a change made at a critical time may eliminate the chance of losing an expensive casting. The important point is that the work is inspected during its progress by an expert. This system does not require the superintendent to keep running about the shop to inspect moulds, as it is applied only to work that needs expert attention. It aims to prevent bad castings instead of blaming a moulder when a casting has been lost. In one of the inspections of the mould for a marine engine, the method proposed for holding down the large cores was changed to one giving more security. The inspections in this case were as follows:—(1) Pattern in place and ready for ramming; (2) mould ready for oven; (3) mould removed from oven; (4) cores placed; (5) ready for final closing; (6) mould clamped and ready for pouring.

Hydro-electric Developments.

A review of hydro-electric developments indicates a marked slackening of activity in new projects in 1928, for although some important plants were put in operation, they had been under construction for some time past. These plants include the Susquehanna River plant at Conowingo, with the largest turbines yet built in this country; the Ohio River plant at Louisville, with the largest propeller-type water wheels; the Feather River plant at Bucks Creek, with 2562ft. head; the Rocky River plant in Connecticut, the first to use pumped water for power; the Chippewa Falls plant, with variable-pitch propeller wheels adjusted by hand; and the Devils River plant in Texas, with variable-pitch propeller wheels adjusted automatically. Theoretical maximum efficiencies are being approached closely in hydraulic turbines, tests on reaction turbines having shown efficiencies up to 94 per cent. At one impulse-wheel plant, new buckets were ordered, and the maker was offered a bonus for any increase in power output due to improved design. The bonus was won, and spurred the maker to still further improvements and higher efficiency. There is increasing use of large butterfly valves instead of head gates in turbine intakes, their principal advantage being in the tightness of seal, and reduction of leakage when the turbine is shut down. A 12½ft. butterfly valve under 130ft. head has shown a leakage of only 2½ gallons per minute. There is increasing use of automatic control, and the Norwood plant has a device which automatically controls the loading of generating units, the governor taking care of sudden load changes in the usual way.

Electric Haulage for Open Mine.

In the operation of the open-air mines of the Utah Copper Company, electric power has replaced steam for the fleet of large excavators, and is now replacing steam locomotives in the hauling system. The steam equipment comprises fifty locomotives of 42 to 75 tons in weight, which can haul seven to ten empty cars of 21 tons each at 6 to 10 miles an hour on the gradients of 1 in 25. The electric locomotives weigh 75 to 90 tons, and can haul ten to fourteen cars at 10 miles an hour on the same gradients. Current of 675 volts is carried on the overhead trolley line and taken off by collector bars on the pantagraph frames of the locomotives. Each locomotive has a pair of four-wheel bogies. Besides the main pantagraph, there are two side collectors for use where the trolley wire has to be at the side of the track. There is also a storage battery and reel with 2000ft. of cable, so that the engine can operate beyond the overhead wire system. On the 40 miles of line already equipped, direct suspension is mainly used, with catenary suspension in the yards. Side poles carry bracket arms, but double-pole or gallows-frame construction is used on bridges. On the working levels, where the overhead equipment has to be moved about every month, the trolley wire is carried by bracket arms on the movable steel towers which carry the 5000-volt feeders for the excavators. Current from a 120,000-volt transmission is stepped down to 40,000 volts and delivered to two automatic sub-stations, which convert it to 750 volts for the trolley line.

Railway Dynamometer Car.

Most of the large American railways have dynamometer cars for use in making tests of new locomotives or to assist in designing such new equipment. One of the latest and largest cars of this type, put in service on the Northern Pacific Railroad, can measure draw bar pull up to 250,000 lb., and buffing force up to 1,250,000 lb. The car is of steel construction throughout, 70ft. long and 9ft. 3in. wide inside the body, mounted on six-wheel bogies, with 36in. wheels. Its weight is about 84 tons. For the drawbar pull piston the effective area is 100 square inches, while for the buffing piston it is 200 square inches. The machinery room at the forward end is 18ft. long, with a raised cupola or monitor roof for a length of 12ft., so that the observers have a good view along the line. Behind this a room 17½ft. long with desks and drawing tables and lockers. Beyond this are toilet and bath-rooms, two sleeping sections, a private state-room, porters' room, and kitchen. For electric light there is an axle-driven generator, storage battery and motor-driven

generator for charging the battery. The recording apparatus marks twenty-two lines or diagrams on the travelling roll of paper, arranged consecutively as follows :—

Six-second intervals.	Locomotive indicator.
Brake cylinder pressure.	Integrator.
Right water meter.	Drawbar pull.
Left water meter.	Buffing force.
Brake pipe pressure.	Reversing lever.
Front air pump.	Regulator.
Rear air pump.	Speed.
Steam pressure.	Distance marks.
Coal or oil meter.	Mile-posts and stations.
Feed-water pump.	One-minute intervals.
Back pressure.	Six-second intervals.

Saving Dust from Pulverised Coal.

At one of the power stations of the Edison Company, at Detroit, efforts have been made to recover the dust from the pulverising mills, both on account of the definite loss in heat and the nuisance from the cloud of dust over the building when the mills were in operation. Originally, the cyclone dust catcher on each mill was vented to the atmosphere. Connecting the vents to the air duct from the driers, so that the dust and drier air would pass through a washer and fan before being exhausted, gave but slight improvement. Passing the vent air and drier through two cyclones in series was also unsatisfactory. The plan finally adopted was to use cloth bag filters, with provision for shaking the dust accumulation from the cloth and for preventing moisture of condensation in the filter, which would cause the dust to stick to the cloth. Each cyclone separator has two sheet iron vertical cylinders, each containing eighteen cotton-cloth filter bags, 8in. in diameter and 8½ft. high, the lower end connected to an inverted cone, with a flap discharge valve at the bottom. The upper end is closed and clamped to a spider. At intervals the bags are shaken by mechanism, at which time there is a slight reverse flow of air into the bags, so that the falling dust does not collect on the inside of the bags, which hang limp during the shaking. To prevent moisture trouble, the filter cylinders, hoppers and air ducts are covered with heat-insulating material, and preheated air is admitted to the vent mixture before it enters the filter. About 45 lb. of coal per hour is collected.

SIXTY YEARS AGO.

THE Truck Act of 1831 prohibited employers in certain trades from paying their workmen's wages in goods or otherwise than in the current coin of the realm. The Act did not, however, apply to home workers, who were technically not employed under a contract of service. It was not until 1887 that the principle of the Truck Act was extended to home workers, and then only in the case of articles under £5 in value and made of cloth, leather, bone, fur, &c. Sixty years ago the wrought iron nail trade of East Worcestershire was still largely dominated by the truck system, for it continued to be carried on as a home workers' industry, and was therefore outside the operation of the Act of 1831. In our issue of May 7th, 1869, we recorded that the "nasmyth's" craft had kept up a persistent struggle against the introduction of machine-made nails or cut nails. At that date it employed about 25,000 workpeople, mostly women and children, but that it was a decaying industry was shown by the fact that thirty years previously over 50,000 workpeople had derived their living from it. In 1869 the horse nail trade was the only branch with which machinery had not become a formidable rival, and which still offered the forger anything like adequate remuneration for his long and laborious toil. The condition of the rest of the workpeople was, in our own words, a disgrace to any Christian country. Among them, extreme poverty, ignorance, and immorality prevailed. The large and respectable masters had certain fixed times for the nailers to "weigh-in" their work. The needier section of the nailers, however, in order to feed their hungry children at home, were forced to weigh-in their nails daily, and sometimes twice a day. The "fogger" offered them the facility for so doing. The fogger was a small master willing to take nails in small quantities. Generally he compelled his clients to take fifteen shillings' worth of truck for every pound's worth of nails. The truck, we reported, was of very inferior quality, and shamefully dear, and the nails were weighed on scales greatly in favour of the buyer. The whole system was one of heartless deceit and plunder. The more humane and respectable factors were endeavouring to put an end to it. If, we wrote, their efforts succeeded, the condition of the nailer would be somewhat improved, but, we added, the trade would never be restored to anything like permanent prosperity until the anvil was exchanged for the machine and the domiciliary smithy gave way to the complete and well-arranged factory.

BOOKS OF REFERENCE.

"THE *Electrician* Annual Tables of Electricity Undertakings, 1929," published by Ernest Benn, Ltd., 154, Fleet-street, London, E.C. 4.—This year's edition constitutes the forty-second consecutive issue of these tables, which give particulars of British, colonial and foreign electrical supply, and electric railway undertakings, whether owned by municipalities and companies. The information afforded is of a most useful character. Particulars of the oil-burning apparatus of various stations using oil fuel are now included, and the additional information regarding the mains and distributors, converting plant, output for the year, showrooms, &c., which has been inserted in the present edition should increase the utility to manufacturers, suppliers and others who have occasion to consult them. Details of further European undertakings are included in the present issue, and altogether particulars of upwards of 800 British and 1300 colonial and foreign undertakings are dealt with.

"THE Mercantile Year Book and Directory of Exporters," which is published by Lindley-Jones and Brothers, Ltd., of 32, Bishopsgate, London, E.C. 2, price 20s., appears this year in its forty-third annual issue. It was founded in 1886, and it is still edited by its founder, Mr. Walter Lindley-Jones. It is eminently what it claims to be—first and last a book for exporters. There is no need for us, at this late date, to go in detail into its contents, but we may say that while being a directory of the names of merchant shippers in this and various European countries, it is also a directory of the houses overseas for whom these merchants act. The present issue extends to 1014 pages, but it is still of a size which is convenient to handle. The information that it gives, which, the preface informs us, has been laboriously verified, is certainly most methodically collated, and that serves to make it a valuable assistance to those with goods to sell in the external markets. The work constitutes a mailing list of carefully selected commercial firms, and it is claimed that admission to its pages is regarded as somewhat of a certificate of responsibility.

"THE Empire Municipal Directory and Year Book," which is published by *Municipal Engineering*, of 8, Breams-buildings, Chancery-lane, London, E.C. 4, for the year 1929–30, price 13s. post free in the United Kingdom, has made its welcome appearance. The present volume, which is the forty-seventh annual issue, possesses all the features contained in its precursors, and, so far as we have been able to test them, the contents have been brought thoroughly up to date. The officially corrected list of local authorities in Great Britain and Ireland now gives particulars of the officials, &c., of 62 county councils, 82 county boroughs, 29 metropolitan boroughs, 252 municipal corporations, 792 urban and 646 rural district councils, 332 authorities in Scotland, and 163 in Ireland, as well as of the leading local governing bodies in the Overseas Dominions. Other sections of the book deal with Road Construction and Maintenance; Plain and Reinforced Concrete and Cement; Lighting, Heating and Ventilation; Municipal Motor Transport; Water Supply, Purification and Softening; Sewerage and Sewage Disposal; Municipal and Public Health Law; Fire Prevention; Housing and Town Planning; Labour-aiding Plant and Appliances; Public Recreation Grounds; and Municipal Engineering, Public Health and Scientific Societies. In these sections much useful information regarding the events of last year is given. There is also a Municipal Engineering and Sanitary Trades Directory. Altogether it is a most useful book of reference.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

HOW DO CENTRIFUGAL PUMPS ACT?

SIR,—The writer has read with much interest Mr. Ure-Reid's letter in your issue of May 3rd, and would express at the outset his pleasure that this most important—and so often discreetly avoided—question has been brought into effective prominence in your columns.

The fallacy so clearly presented by Mr. Ure-Reid appears to the writer to spring from a more fundamental fallacy, frequently ignored in treatises on the subject—namely, the false assumption of the uniformity of the flow at all points on a circumference. Dr. Pfleiderer, in his "Die Kreiselpumpen," brings this point out clearly, though the writer does not entirely agree with his subsequent treatment of the problem. The subject has also been dealt with by the writer in a paper on "Axial Flow and Centrifugal Pumps,"* where an attempt was also made to picture the chaotic conditions existing near the blade tips of a turbine pump, particularly at decreased deliveries.

The fallacy referred to—namely, the variation of conditions along a circumferential arc—may easily be demonstrated. For were the pressure uniform, there could be no pressure-difference between the front and back of an impeller (or guide ring) vane, and therefore no torque. Now by the laws of hydrodynamics variation in pressure involves variation in velocity. Thus in an impeller the relative velocity at the high-pressure region near the driving face of a vane is less than that behind a vane where the pressure is lower.

Only near the centre of each impeller (and guide-vane) "cell" can the triangle of velocities approximate to the ideal given in most text-books, and such approximation occurs even there only at normal load. Near a driving surface it more nearly resembles A c B in Mr. Ure-Reid's diagram, while near a trailing surface the absolute velocity becomes more nearly axial. This is made very clear (for an axial-flow pump) in Fig. 12 of the paper† above referred to.

As the delivery is reduced, the point the conditions at which can be generally represented by the ideal triangle moves circumferentially forward nearer to the trailing surface, the triangle for conditions at the trailing surface becoming more like the ideal, and at the leading surface flatter and flatter. As throttling increases this triangle in time reverses itself, the "impeller-cell whirl" swamping the "through" velocity.

It is not suggested that the above is a complete picture of the action in a centrifugal pump—the action is far too complex to be thus briefly dealt with. But it does appear to give a clue towards solving Mr. Ure-Reid's question in that, up to a certain departure from normal conditions—

(1) The ideal triangle A C B remains approximately applicable for a certain point in each cell, and at this point the relative velocity is as given by the ideal triangle.

(2) The point in question advances as throttling proceeds.

(3) There may be another point (further back) at which the triangle A c B is applicable.

(4) The relative and "through" velocities vary greatly from vane to vane, and their value near a blade surface is not in general equal to their mean value.

Has not Mr. Ure-Reid assumed such equality at the point B?

You, Sir, in a most interesting leader in your current issue, draw attention to the inflexible consistency of Nature. It is mainly on this consistency, extended by the laws of similarity and applied to empirical data, that designers of centrifugal pumps ultimately depend. It is true that calculations are made which purport to be based on theoretical considerations, but factors have invariably to be introduced to reconcile theory with observed results. In fact, the more closely one studies the very complex action in these machines, the more one blesses Nature for another of her virtues—her will to help mankind. Careful analysis postulates discrepancies and shocks which would seem to bar all approach to high efficiency, and yet Nature so accommodates herself to the crude conditions imposed by man as to give him in practice the excellent results on which he is pleased from time to time to congratulate himself.

H. R. LUPTON.

Leeds, May 6th.

* Pfleiderer, "Die Kreiselpumpen" (Berlin, Julius Springer, 1924), pp. 70 *et seq.*

† H. R. Lupton and J. H. W. Gill, "Low Lift Axial-flow and Centrifugal Pumps." Paper read b fore Section G of British Association, September 6th, 1927.

THE REGISTRATION OF TESTS.

SIR,—In your number of January 25th, 1929, you published an article under the above heading.

In view of the very clear and candid way in which you set out many of the evils which confront both the purchaser and seller of power plant, we are surprised that no engineering body in this country appears to have taken up this very necessary and important matter. We should have thought that either the Institution of Mechanical Engineers or three or four well-known power plant and machinery insurance companies would have welcomed the opportunity of drawing up a code of rules and regulations of tests under which independent and unbiassed trials could be carried out. (Of course, where consulting engineers are appointed by the purchasers to carry out the installation, they have their own staff for checking such tests.) These trials need not be confined to purchasers or sellers of power plant, but be employed for research and fuel economy purposes.

We know that in Finland there is the Foreningen for Kraft-och Bransleekonomi (= Association for Power and Fuel Economy) in Helsingfors. This Association consists of most of the manufacturers in Finland, Sweden and Norway who own fuel power plant, and by means of an annual subscription maintain in Helsingfors an engineering office which acts as consulting engineers for all subscribers for the purpose of planning new, extending or modifying old plants, making tests, &c.

For BELLISS AND MORCOM, Ltd.,
JOHN BELLISS, Director.

Birmingham, May 6th.

CLASHING ENGAGEMENTS.

SIR,—Your editorial comment on the subject of clashing engagements, in the current issue, deserves careful consideration. Anyone who takes an interest in more than one of the learned societies will be able to add other examples from his own experience.

This is surely an opportunity for the Engineering Joint Council to prove its worth. If the work cannot be undertaken by the Institution providing the secretariat, no difficulty should be found in appointing a Fixtures Secretary from one of the other Institutions, to whom all fixtures should be notified. He would then circulate a list of the fixtures of all the participating societies at the beginning of the session, and would be consulted before others were arranged.

Such a scheme has been in operation for the last eight years in a group of small societies, and has proved to be a solution to an otherwise troublesome problem. The cost is negligible.

P. W. THOMAS.

London, S.E. 7, May 4th.

THE HEAVIEST EUROPEAN PASSENGER LOCOMOTIVE.

SIR,—Your correspondent Mr. A. G. Gieslingen, in his letter in your issue of January 18th, 1929, page 80, giving some information concerning the new Austrian locomotive, states that the location of its boiler centre, namely, 11ft. 2in. above rails, is the highest in the world.

I would like to be allowed to point out that at least, so far as recent Russian design, which I take liberty to mention, is concerned, Mr. Gieslingen's statement is incorrect.

So long ago as 1927 there was delivered by the Putilovsky Works the first three-cylinder locomotive in this country to meet requirements of heavy passenger traffic on several State railways. This design has, among other new features, embodied a highly elevated boiler. The centre line of the latter lies 11ft. 4in. above rails, *i.e.*, 2in. higher than in the quoted Austrian locomotive.

C. CHAIKOVSKY,
Mechanical Engineer, Kolomna Works.

Golutvin, April 29th.

A STEEL fabricating plant is to be put up at Vancouver by the Dominion Bridge Company.

Railway and Road Matters.

THE death occurred on May 6th of the supervisor of the travelling post-office who was injured in the Charfield accident of October 13th last. That will not be recorded as the death of a passenger, but of an "other person," *i.e.*, neither a passenger nor a railway servant.

THE locomotives on the western section of the Southern Railway are singular in that they carry a head code. This is a number and indicates the turn of duty to which that engine belongs, *i.e.*, the trip from the shed to the station or yard for its first duty; then the various trains it works during the day, and the return trip to the shed at the end of the day's work. Signalmen have copies of these turns of duty, and, by the number exhibited, can tell the destination of the train.

ANOTHER illustration of the carelessness of some railwaymen as to their own safety, supplementing that given in this column on April 26th, is revealed in the report by Mr. Moore on a fatal accident to a sub-ganger at Grantham. He was one of three men who were proceeding along the down line with their backs to on-coming trains. Mr. Moore remarks:—"This deliberate disregard of one of the elementary principles of a railwayman's duty, namely, to face the traffic on all possible occasions, is especially deplorable in view of the fact that the individual periods of service of the three men concerned ranged between sixteen and twenty years."

HISTORY, as regards railway legislation, was made in Parliament on April 26th. The proposal for a siding over a main road had been passed by a Select Committee of the House of Commons, but had to face a similar ordeal in the Upper House. The applicants were the Great Western Railway Company, which wanted to lay a siding over the main road at Hayes in order to give communication with the works of the British Electric Transformers, Ltd. Colonel Sir John Pringle, the chief inspecting officer of railways, who attended on behalf of the Ministry of Transport, agreed that a new level crossing was most deplorable if it could be avoided, but it would be a strong argument in favour of such a crossing that it would relieve the roads of heavy traffic. The level crossing was then passed, and the Bill has since been read a third time.

THE annual report of Sir Henry Thornton, president of the Canadian National Railways, for 1928, presented to Parliament on April 10th, indicated a great improvement in the position of the system as compared with the previous year. The operating revenue reached the record figure of 276,631,921 dollars. After payment of operating expenses amounting to 218,248,248 dollars, and taxes amounting to 5,000,000 dollars approximately, and other charges, the total surplus income was 53,213,795 dollars, as compared with 40,789,724 dollars for 1927, a gain of 12,424,074 dollars, or a reduction in the operating ratio of from 81·75 per cent. to 78·89 per cent. The total traffic receipts for the year reached the high figure of 304,591,268 dollars, being exceeded only by the Pennsylvania and the New York Central systems. While this marked improvement was taking place betterments were being carried on in every department of the system, and the construction of nearly 200 miles of branch lines. The system's debit balance in 1929 was 477,374,119 dollars, as against the January 1st, 1928, debit balance of 443,912,657 dollars. The system's net income deficit, including the eastern lines, was 24,730,410 dollars, as compared with 34,373,027 dollars in 1927, a betterment during the past year of 9,642,617 dollars.

FROM the report of Lieut.-Colonel Anderson on the collision of February 12th at Doe Hill on the Erewash Valley line of the London, Midland and Scottish Railway, it is seen that there was simultaneous failure on the part of four men—principally the signalman at Morton Sidings, who omitted to set his points properly and to actuate a signal which, had he done so, would have revealed his error, and to a less degree the driver, fireman and guard of the goods train, because they failed to notice that their train did not pass through the crossover from the down passenger to the up passenger line. As a consequence, the goods train proceeded on the facing road and was run into, engine to engine, by a down express, the enginemen of which were killed. There was, it seems to us, justification for the signalman not working the signal above mentioned, as it was 100 or so yards in the rear of where the engine came to rest before it proceeded forward, as was intended, on the up passenger line, and "the special instructions issued by the company for working this box do not deal with this matter." Colonel Anderson therefore recommends a shunt signal at the points. He would add that had this section of line been equipped with lock-and-block the express could not have been accepted unless the shunt signal had been worked and its operation was not possible so long as the crossover lay for the down line.

THE extent to which persons, even in high places, are ignorant of the facts as to the privately owned wagon is really surprising. Thus, Mr. J. H. Thomas, speaking at Derby on May 5th, said that it was only after years of agitation that the railway companies were persuaded to adopt the pooling system of their own wagons, and to-day the wastage which exists in the operation of private wagons is the same as that which existed in the use of railway companies' wagons before the pooling system was introduced. Mr. Thomas should, we consider, know that the conditions are not comparable. Railway wagons—*i.e.*, those used for general merchandise—can usually be employed to carry a return load; coal wagons must return empty, as they are unsuitable for any other traffic. It is not true either that there were "years of agitation" before the "common user" of wagons—a different thing to pooling—was adopted. There were difficulties and, even to-day, a very large number of railway-owned wagons are outside the scheme. But when common-user was first adopted by the Great Northern, Great Eastern and Great Central in December, 1915, and by the London and North-Western, Great Western, Midland, North-Eastern and Lancashire and Yorkshire in March, 1916, not only were the national interests of first importance, but the railways were controlled by the Government, and so the objections of a company having its well-maintained wagons used by a company whose upkeep was less satisfactory went by the board.

Notes and Memoranda.

A PAPER read in Germany describes and illustrates a compact form of high-tension condenser in which the breakdown voltage is raised considerably by maintaining the air dielectric at a pressure of 10 atmospheres. A cylindrical condenser of capacity 42 micro-microfarads for use up to 300 kV has a vertical length of only 250 cm.

THE International High-Tension Conference which was founded in 1921, under the auspices of the International Electrotechnical Commission, and which is, apart from the latter, one of the oldest and most important international bodies dealing with electrotechnical matters, has arranged to hold its fifth session in Paris from June 6th to 15th. Already 380 members from twenty-one countries have signified their intention of being present, and it is anticipated that the 1927 attendance of 544 delegates will be exceeded. Altogether ninety-eight papers have been sent in from eighteen different countries.

THE new 60,000-kilowatt turbo-generator recently installed in the Lakeside plant of the Milwaukee Electric Railway and Light Company takes its place among the largest single-cylinder complete-expansion turbines thus far constructed. It is the first of the size and type made by the Westinghouse Electric and Manufacturing Company. In its construction the principal features are the use of the impeller-type oil governor in the place of the mechanical flyball type, the use of a new type of fastening in the last three rows of reaction blading, the single-anchor method of supporting the cylinder and the provisions for insuring easy starting.

IN accordance with its annual custom, *Vulcan* publishes in its April issue an analysis of the breakdowns that occurred to electrical plant under the insurance of the Vulcan Boiler and General Insurance Company, Ltd., during the year 1928. Notwithstanding the fact that the percentage cost of repair of alternating-current motors insured was greater than the percentage cost of repair of direct-current motors, the percentage number of breakdowns was considerably greater in the case of direct-current motors. This is accounted for chiefly by the fact that a large number of the breakdowns which occur to direct-current motors are to the commutators, which can be repaired at a relatively small cost, whereas with the alternating-current machines the breakdowns are generally on the stators in the case of squirrel-cage motors and to the stators and rotors in the case of slip-ring motors, and in nearly every instance it has been found necessary entirely to re-wind the affected part, which is a costly operation.

A CURIOUS explosion arising from the bursting of the casing of a centrifugal pump is referred to in *Vulcan*. The failure occurred at a soap works. The pump, which was of the ordinary belt-driven centrifugal type, 15in. in diameter, was used to transfer liquid soap, or lye, from one vat to another. The casing was in two parts, united by fifteen set bolts ¼in. diameter, and the castings were ¼in. thick. It was customary to clear the suction pipe and the pump by steam from the boiler, at a pressure of about 60 lb. to the square inch, and also to admit steam for this purpose if the soap became too viscous. The steam was admitted through a 1in. pipe, and the supply regulated by a 1in. stop valve, but there was no pressure gauge, relief gauge, or reducing valve, fitted between the stop valve and the pump, and if the soap were sufficiently viscous and was under a sufficient head of pressure there was nothing to prevent the pressure in the casing becoming equal to that in the steam supply pipe. For this pressure the pump casing was inadequate, and it was no doubt this inability on the occasion in question which led to the bursting of the pump, and serious injury of an attendant.

A PAPER read a short time ago before the Wireless Section of the Institution of Electrical Engineers describes a high-frequency radio apparatus capable of measuring in absolute units the intensity of the electro-magnetic field over the frequency band of 5 to 12 megacycles per sec. It is easily portable, since the total weight without batteries is only 60 lb. An untuned antenna, which is coupled to the grid of the detector valve in an unusual manner, is used to pick up the energy to be measured. Sensitivity is not seriously affected since the range of intensities which can be measured is from 10 microvolts per metre to 10,000 microvolts per metre. The screening difficulty is lessened by using a resistance attenuator and toroidal inductances, and by totally disconnecting the aerial during calibration. The set consists of a detector valve with which is associated a control valve. One stage of audio-frequency amplification follows the detector, and a diode used as a second detector allows a galvanometer to be used for the signal comparison. A separate heterodyne is used to obtain the audio frequency. A resistance method is used to attenuate the current from the local source. The complete apparatus has been subjected to a series of tests in self-consistency and absolute value, and these are described in the paper.

IN the course of a comprehensive investigation of the reduction of magnetite by molten sulphides, undertaken in co-operation with the University of Arizona, it became necessary to devise a method of making crucibles of a suitable material which would hold such melts. Pure electrically fused magnesium oxide, mixed with 3 per cent. alumina, was ground to pass 350 mesh. A suitable quantity of the mixed oxides was moistened with 7 per cent., by weight, of 25 per cent. magnesium chloride solution, and tamped firmly into a three-piece mould lined with heavy paper to form a slug having the shape of the outside of the crucible desired. The mould was then placed in the chuck of a lathe and the slug was hollowed out to form a crucible which, after drying, was fired in a high-frequency induction furnace at a temperature increasing over a period of two hours from that of the room up to 2100 deg. Cent. Crucibles so prepared are very dense and will hold a molten mixture of iron sulphides and oxides for forty-five minutes at a temperature of 1500 deg. Cent. without appreciable seepage. The melt will take up in that time about 2·5 per cent. magnesium oxide. This may be considered very satisfactory when one takes into account the temperature, the corrosive nature of the melt, and the relatively large surface presented to the melt by very small crucibles.

Miscellanea.

FROM an article in the *Sun*, of Baltimore, we gather that the American Navy Department has done us the high honour of adopting as an official communique many passages from an article on the "Ersatz Preussen," which appeared in THE ENGINEER on January 11th.

A STEEL caisson for the Devonshire dock entrance, Barrow, of the London, Midland and Scottish Railway Company, was recently launched by Vickers-Armstrong. The top of the caisson is formed into a roadway; six watertight compartments are fitted, and the caisson has to withstand a pressure of 28ft. of water on either side.

THOUGH it is possible that some of the mysterious and complete disappearances of vessels at sea may have occurred as the result of a boiler explosion, it is impossible to push such a theory beyond the verge of surmise. Board of Trade Report No. 2955, however, establishes clearly that in the case of the foundering of the steam drifter "Gleam of Hope," on August 14th last, off the coast of Lewis, the failure of the boiler shell was the cause.

THE first automatic telephone exchange of its kind in this country has been opened at the village of Haynes, in Bedfordshire. The nearest operator is at Bedford, nearly seven miles distant, but the twelve local subscribers in the village will be able to make local and trunk connections by day and night, and a kiosk will enable the public to make calls as desired. Very little attention will be needed by the mechanism of the installation and this only at long intervals.

DURING January last, according to the *Wireless Trader*, the exports of radio apparatus from this country were valued at £123,190, including valves, £17,365. The Netherlands was the principal customer, taking goods to the value of £18,048, including valves £201. Japan was next with £17,185 (valves, £1367), and Australia third with £10,460 (valves, £1439). Other important customers were the Irish Free State, £7947 (valves, £1890); Rumania, £7491 (valves, £1379); and France, £5746 (valves, £476).

THE Belfast Harbour Commissioners have decided to construct a new dock at a cost of £302,000 on the County Antrim side of the river opposite Harland and Wolff's shipyard. The dock will have a number of quays 500ft. long and a shed 600ft. long. The Commissioners also agreed to lease to Joseph Rank, Ltd., the English firm of millers, a large piece of ground adjacent to the new dock for a new flour mill. We understand that the firm will be the first British firm to build a mill in Northern Ireland.

IT is not perhaps generally known, states the *Electrician*, that the Vienna transmissions of still pictures by the Fultograph method on 520 m. are often relayed by Linz on 350 m. When Vienna is jammed this station is frequently to be found coming through well. In addition to the Koenigswusterhausen transmissions of still pictures, Berlin (Witzleben) has lately been conducting a transmission at eight o'clock on several evenings during the week, and sometimes this is relayed by other German stations.

THE Summer Meeting of the Overhead Lines Association will be held in Mid-Cheshire early in July, by invitation of the directors of the Mid-Cheshire Electricity Supply Company, Ltd., and of their President. The local arrangements will include the inspection of the new designs of sub-stations for bulk supply for small towns, suburbs and villages, from the 33-kV main system; also some representative country lines, some carried on native timber poles treated on the Cobra process, single-phase, 3300-volt, with special guarding and compound lines, 3300-volt and 220-volt, on the same poles.

A GROUP of engineers and specialists will be sent to Soviet Russia, by the Freyn Engineering Company of Chicago, to help plan, design and build new iron and steel works. The American engineers will also assist in the reconstruction and modernisation of existing plants. They are to co-operate with Gipromez, the State Institute for Projecting New Metal Works, at Leningrad, U.S.S.R. The contemplated programme of the Soviet Government in the next five years calls for the building of ten new iron and steel works, as well as extensive remodelling. The estimated value of investments to be made in the iron and steel industry alone is said to exceed £200,000,000.

THE annual report of the Bureau of Electricity of the New York Board of Fire Underwriters states that during 1928 inspections of the complete wiring of 4970 buildings, in which were 18,489 separate equipments, were carried out. Of these, 10,368 were found to be unsatisfactory, and in many cases unsafe. Since the re-inspection service was commenced on its present scale, approximately seven years ago, some 26,233 buildings have been examined. The Bureau had 1220 fires of reported electrical origin called to its attention during 1928. It was found upon investigation that 1015 of them could be attributed to electricity, and between them they caused an aggregate loss of 254,706 dollars.

AT a shareholders' meeting of the Brompton and Kensington Electricity Supply Company, Mr. H. R. Beeton explained that it was not until October 15th, 1928, that the company took all of its supply from the London Power Company and closed down its own generating station. The year was therefore one of transition. The company had sold 14 per cent. more current, and earned upwards of 33 per cent. more profit. Those results represented only a partial realisation of the benefits which would accrue from consolidated generation. The accomplishment of the new system necessitated the erection of an entirely new transforming and bulk distributing station, and the change of periodicity from 83 cycles to the standard periodicity of 50 cycles. It involved an inventory being taken on the premises of approximately 11,000 consumers, the changing of 160 street transformers, and the replacement and adjustment of 12,000 meters, as well as the substitution, renewal, or adjustment of over 500 motors, lifts and other apparatus on the premises of consumers. The change-over was effected during eight successive Sunday mornings at 6 o'clock, and it was completed not only without any interruption, but without inconvenience to consumers. The cost of the work with concurrent alterations involved a capital expenditure of nearly £70,000.

CONSTRUCTIONAL WORKS ON THE WELLAND SHIP CANAL

(*For description see page* 511)

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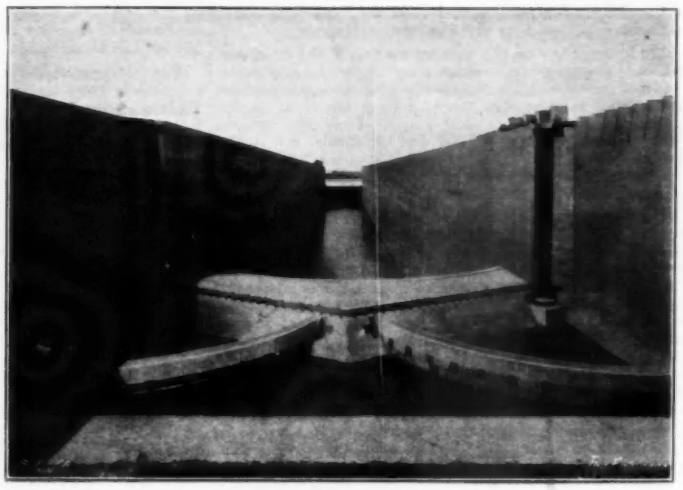

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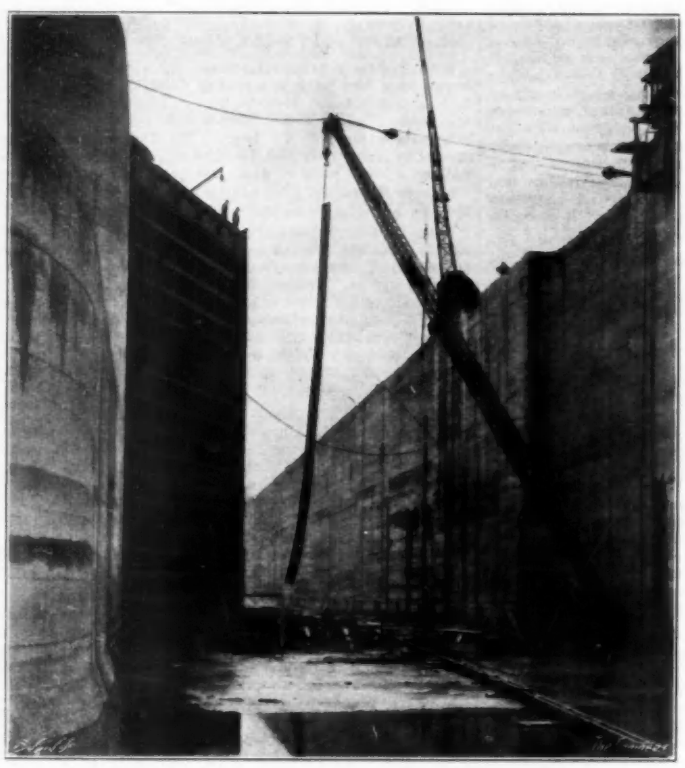

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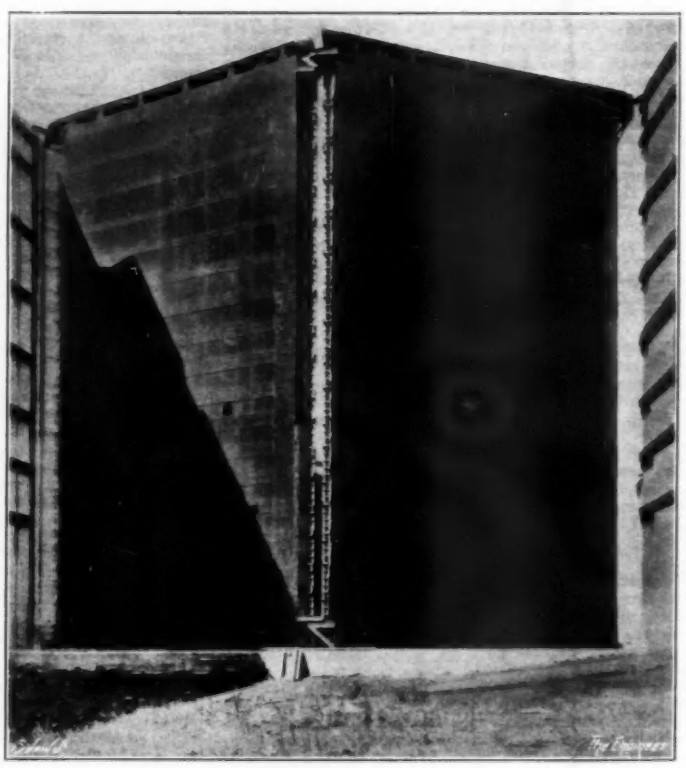

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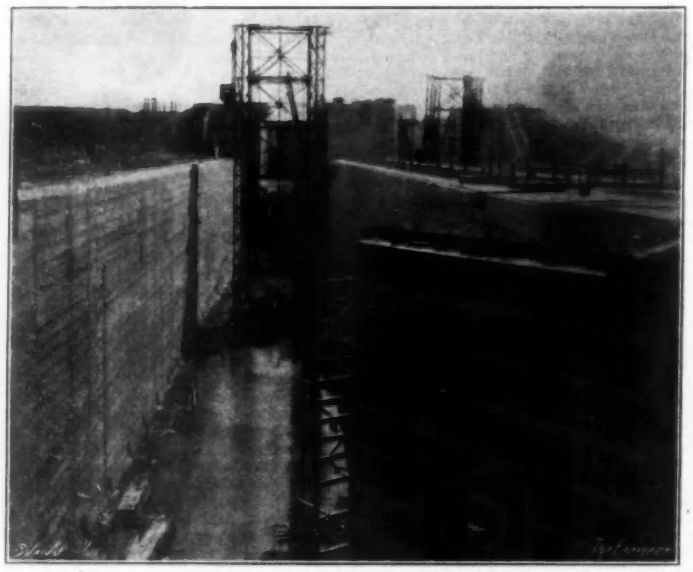

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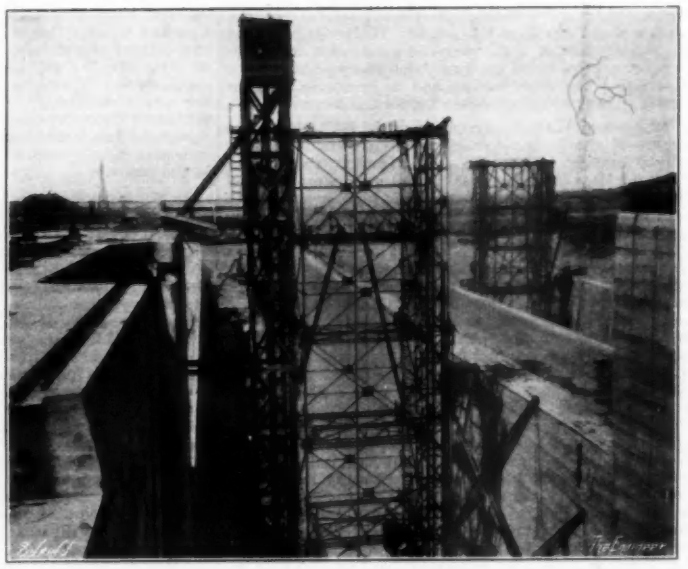

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THE ENGINEER.

MAY 10, 1929.

Naval Disarmament Prospects.

THE question of naval disarmament has once more assumed topical importance in view of the speech delivered by Mr. Hugh Gibson, the United States representative, before the Preparatory Commission on Disarmament at Geneva on April 29th. No country in the world is more interested in this question than Great Britain, to whom adequate naval power has been for many centuries the first condition of security and prosperity—nay, of very existence. It is, however, not surprising that the initiative in making a fresh move towards the restriction of combatant fleets should have been left to America. Since the abortive Geneva Conference two years ago there has been a very general feeling here that little was to be gained by making new overtures to the United States in regard to this particular problem. To speak frankly, the American attitude at Geneva was not encouraging, while the reception accorded at Washington to the tentative Anglo-French naval compromise last year was accepted as evidence of America's disinclination to reopen the subject of naval limitation, except at her own selected moment. Judging from Mr. Gibson's speech, that moment has arrived. Congress in the interval has authorised a great shipbuilding programme, which, if carried out, will give the United States a definite lead in heavy cruiser strength. Moreover, there has come into office a President who, having travelled extensively abroad, has a wider experience of foreign countries than the majority of his predecessors enjoyed. We may take it that Mr. Hoover appreciates the many-sidedness of the naval problem, and realises that it is much too complicated to be solved by a stroke of the pen. So much may, indeed, be inferred from the speech of his representative at Geneva, which expressed a readiness to modify the American attitude that was responsible, in part, for the failure of the last Conference.

Unless a spirit of give and take prevails, conferences on disarmament are not merely useless, but positively harmful. That spirit was not conspicuously present at the Geneva gathering in 1927, and the breakdown that followed has had an undesirable effect upon Anglo-American relations. It is a platitude that friction between nations is almost always due to mutual misunderstanding, but in this particular instance the homely truth needs to be emphasised. Until quite recently, at any rate, public men in America evinced no understanding of the British position in regard to naval armaments. They persisted in treating the naval situations of the two countries as analogous, whereas they are fundamentally different; they worked out a formula of relative strength sufficient for American requirements—which, in sober fact, are much more limited than our own—and then, when Great Britain declined, politely but firmly, to accept a demonstrably inadequate allotment of naval power, accused her of imperialistic tendencies, and threatened to punish her by building a fleet of such magnitude that she would be relegated to second place in the naval hierarchy. In England, on the other hand, there has been a marked failure to comprehend the American point of view. That the United States, with its population of 120 millions, its enormous industrial capacity, its thriving and increasing foreign trade, its boundless wealth, and, above all, the commanding position in world affairs which it has come to occupy, should desire to be worthily represented at sea is surely natural enough. From the dawn of civilisation, naval power has been at once the symbol and the concrete expression of national aggrandisement, and in deciding to cultivate this power the United States is only following the historical example of other nations, England included. It is of the first importance that British public—and official—opinion should understand that the United States, in aspiring to become a maritime Power of the first order, is simply obeying the irresistible impulse of destiny. Equality in sea strength as between the two nations was agreed upon at Washington nearly eight years ago. Previously, America had been building sixteen great capital ships, which would, it was claimed, give her absolute supremacy afloat. In view of the concurrent programmes of Great Britain and Japan, which included ships superior in tonnage and armament to the American vessels, that claim was exaggerated. Unfortunately, however, the American people have been encouraged to believe that they voluntarily sacrificed naval primacy in the cause of disarmament, and, further, that the machinations of other Powers, headed by Great Britain, have rendered their sacrifice futile. The facts are very different. Great Britain has scrupulously observed the Washington Treaty, both in letter and spirit. Since the Washington Conference she has been progressively reducing her naval forces. Even the modest five-year replacement programme enacted in 1925 has been drastically pruned. But our example has not been followed elsewhere. Foreign naval expenditure has steadily increased, while ours has steadily declined. Since the Treaty was signed, the United States has legislated for twenty-three cruisers of 230,000 tons; within the same period the British Empire has provided for twenty cruisers of 190,000 tons. In proportion to the pre-Treaty ratio, the fleets of Japan, France, and Italy have all been substantially enlarged. Great Britain has consistently advocated reduction in the size of warships. The United States, on the other hand, has held out for maximum dimensions. In the light of these facts, it is manifestly absurd to accuse us of hampering the progress of naval disarmament. It now appears that the United States is willing to give favourable consideration to those questions which it has hitherto refused to discuss, namely, the reduction of warship dimensions and the devising of some formula which, while maintaining the "parity" principle, would enable Great Britain to make reasonably adequate provision for the protection of her far-flung trade communications. There is as yet no sign of America's willingness to accept a lower cruiser standard than the 10,000-ton 8in. gun type, but it is suggested at Washington that the factors of displacement, age, speed, armament, and radius might be weighed when assessing tonnage quotas. That is a very sensible proposal. The bulk of our cruiser fleet consists of small and lightly armed ships, many of them prematurely aged by the rigours of war service. It is unfair to class such vessels as equal to the new 10,000-ton cruisers, yet they are invariably so classed by American propagandists. When the United States has completed its current programme, it will possess thirty-three big ocean-going cruisers, an aggregation of fighting force much superior to the British cruiser fleet, in spite of the latter's superiority in numbers. It remains to be seen whether the United States, in its desire to promote further naval restriction, will agree to limit the number of 10,000-ton units, and, when that limit is reached, accept a smaller type of ship as the common standard. That, we consider, is the only possible method of

achieving true cruiser equality. The argument that America, owing to the paucity of her oversea bases, must have very large cruisers, while the British Empire, which has numerous fuel stations abroad, only requires small cruisers, is entirely fallacious, while the further contention that Britain's fleet of liners must be reckoned as potential cruisers in any scheme of limitation is irrelevant. Such arguments may be useful for propaganda purposes, but it is to be hoped that they will be excluded at the next naval conference, where their introduction could only lead to barren and perhaps acrimonious controversy. According to news from Washington, American naval authorities are prepared to discuss a reduction in the battleship standard established by treaty. Great Britain has twice proposed a maximum of 30,000 tons for future ships, instead of the existing limit of 35,000 tons, and a lowering of the gun calibre from 16in. to 13·5in., but until recently there had been no response from America. The approaching end of the "naval holiday" invests this question with importance, for unless the Treaty is modified in the interim we shall have to lay down two battleships in 1931, and the prospect of expending £8,000,000 on each ship will not appeal to the taxpayer. It is to be noted that in the advance American Navy Estimates for the next financial year provision is made for beginning two battleships, unofficially stated to be of 35,000 tons, with nine or ten 16in. guns. There are, we understand, very few naval officers who seriously contend that 35,000-ton ships are necessary.

It must be admitted that the obstacles in the way of a new naval agreement calculated to give universal satisfaction are still formidable enough. They are not necessarily insuperable, however, and if, as now seems evident, the United States intends to co-operate with this country in the friendliest spirit, there is little doubt that the combined influence of the two leading naval Powers would overcome all difficulties. Nothing would contribute so much to international harmony as a definitive settlement of the naval issue as between Great Britain and the United States.

Broken Wires in Suspension Bridges.

THE news that a serious breakage of wires has occurred in the cables of large new suspension bridges in America—the Mount Hope Bridge in Rhode Island and the Detroit Suspension Bridge—naturally arouses much interest and possibly some degree of concern, not only among engineers, but also among those interested in the development and production of alloy steels. The facts as at present known were given in THE ENGINEER for April 12th and 26th. Without going into details, the facts may be briefly recalled. Breakages of wires in the cables of the Mount Hope Bridge were detected during the erection of the bridge, when the laying of the ferro-concrete floor slabs was about to begin. The number of broken wires continued to increase in spite of immediate steps taken to reduce the load on the cables, and ultimately it became obvious that the cables would have to be replaced by others. An inspection of the cables of the Detroit Bridge, in which similar wire had been used, also revealed a number of broken wires, and there also replacement was decided upon. These, it is claimed, are the first cases of serious failures of bridge suspension systems recorded in modern times. The most interesting, and at first sight somewhat startling, point is that the wires were of a new type, being made of heat-treated alloy steel instead of the hard-drawn carbon steel employed in earlier practice. Full details of the specifications and tests applied to the wires and of the actual loads carried by the cables at the time of failure have been given in the American technical Press, and engineers and metallurgists will appreciate the frankness and rapidity with which the facts have been made public. On the figures as they stand the cables should have been strong enough to bear not only the load imposed during construction, under which they failed, but the far heavier working loads which were provided for in the design. That failure did nevertheless occur in two of the cables of the Mount Hope Bridge is therefore seemingly one of those mysterious events which from time to time disconcert the engineer.

Whilst it is difficult to arrive at any definite conclusion in such a matter until the whole case has been subjected to an exhaustive inquiry, including full examination of the wire by physical and metallurgical methods, there are, of course, several possible explanations of the failure. It is clear either that the wire—when it actually broke—did not possess the strength which test results had indicated, or, perhaps less likely, that the loads were greater than had been estimated. When we suggest that the wire did not, in fact, have the full strength indicated by the test figures, we contemplate a number of possibilities quite apart from the obvious one that the material tested did not truly represent that put into the cables. If, for the sake of discussion, we exclude such possibilities which in practice cannot be entirely disregarded, a little consideration shows that we may have to do either with some treatment which the wire received during manufacture, transport or erection, which injured it either generally or locally, or the steel selected may have been insufficiently uniform and may therefore have developed unexpected local weakness. Difficulties with heat-treated alloy steel wire are not by any means unknown in this country in other connections, as, for example, in the production of the highest class of spiral springs. In that case, however, the wire is exposed to rapid alternations of stress and failures due to surface defects or to corrosion fatigue no doubt play a part. In the Mount Hope Bridge fatigue stresses scarcely existed, while the time during which corrosion could occur was very short. Yet minute local defects in the wire resulting from heat treatment processes insufficiently adapted to the needs of material in which the surface plays so important a part may well prove to be responsible for the trouble. It is certainly significant that in the Mount Hope Bridge failure seems to have been confined to two of the cables, the remainder showing no signs of trouble. Since the bridge was in an advanced stage of construction, the loading of all the cables must have been nearly the same, and the reason why only two of them showed failures may lie in the material or treatment of these particular cables. The trouble may have been caused by some error in the handling of the wire during the erection of these two cables, while no such error was made with the others. On the other hand, it seems rather more likely that the source of the failures will be found in some special factor operating in the manufacture and treatment of the batch of wire used in each of these two cables, since an individual cable would presumably be spun out of one batch of wire.

It is clear that without much more detailed data which can only be obtained from an exhaustive inquiry we can do little more than indicate the directions in which the causes of such a serious failure may be sought. It is to be hoped that such an inquiry will take place, preferably by an entirely independent investigator, and that, in the interests of engineering in general, the whole of the findings and the evidence upon which they are based will be made available with the same frankness and promptitude that has characterised the publication of information in regard to this matter so far. Although British engineers are not very immediately concerned with the problems of long-span suspension bridges, the present case of failure stands, until it is cleared up, as a seeming blot upon the record of alloy steel in large-scale structural use, and it is eminently desirable that the possibly injurious inferences which may be drawn from it should not be permitted to rest upon mere speculation as to the cause and nature of the trouble. We would suggest that it would be extremely unwise to base upon this unfortunate American experience any sense of doubt or hesitation in regard to the future structural uses of alloy steels. In the first place, as we have already pointed out, the importance of surface defects is undeniably greater in wire than in material of greater thickness. Next, the rapid heat treatment of wire under conditions of mass production cannot fairly be compared with the careful heat treatment which can be given to material in other structural forms. Finally, even if it should be proved that in some way the particular type of alloy steel used in these American bridges was unsatisfactory in its behaviour in the form of heat-treated wire, that condemnation could logically be applied only to that particular type of steel and to that particular treatment and use. It would be illogical and extremely unwise to conceive, out of these unfortunate failures, anything like a general prejudice against the structural use of heat-treated alloy steel.

The Central Electricity Board.

THE first annual report of the Central Electricity Board, covering the period from the setting up of the Board on March 1st, 1927, to December 30th, 1928, was issued on Tuesday of this week, thus adding another publication to the collection that has been brought into existence since the Government took the electricity business in hand. After considering the circumstances which led up to the passing of the Electricity (Supply) Act, 1926, and the objects for which the Board was constituted, the report goes on to consider the salient facts relating to the Central Scotland, South-East England, Central England, North-West England and North Wales, and Mid-East England schemes, all of which have been dealt with in our columns. Following this comes a description of the "grid" system, which will consist of some 3000 miles of overhead lines operating at a pressure of 132,000 volts between phases. The system, it is pointed out, differs from those of the Continent and the United States, which have been developed mainly to transmit large blocks of power over long distances from localised water power or brown coal areas. In Great Britain, on the other hand, the availability of suitable coal over wide areas and without wide variations of price, coupled with the fact that the country has no large water power resources, calls rather for a system of interconnection, which will serve the two-fold purpose of an elongated bus-bar giving economic production and a source from which the electric supply industry can draw all the bulk supplies it requires. The possibility of employing cables in places where they may prove to be desirable appears to be one of the main reasons for fixing the transmission pressure at 132,000 volts. Shortly after the Electricity Commissioners transmitted the first scheme to the Board, the International Electro-Technical Commission, in fixing standards for E.H.T. transmission lines, abandoned 132,000 volts as a standard and now has no intermediate steps between 110,000 and 165,000 volts. Investigations showed that if the voltage was raised from 132,000 to 165,000 volts the capital expenditure of the grid would increase by 12 per cent. without making it possible profitably to utilise the increased carrying capacity which would thereby be obtained. As regards secondary transmission, some 93 circuit miles of 66,000-volt single-core cable will be laid in the inner London area, but by far the greatest proportion of the other secondary lines of the Board will be overhead lines carried on lattice steel towers and operating at 33,000 volts.

The difficulties of obtaining wayleaves and consents to the erection of an extensive overhead transmission system, and particularly the difficulty of obtaining sites for towers in the more populous districts, made it essential that, with due regard to cost, the maximum possible length of span between supports should be adopted. This consideration at once suggested the use of steel-cored aluminium conductors. Another important factor in determining the choice of aluminium and steel for the 132,000-volt lines was the comparatively large diameter of the composite conductor, *i.e.*, 0·77in. This sets the critical corona voltage under normal atmospheric conditions at approximately 184,000 volts and ensures that the corona power losses will be negligible.

In order to provide an electrostatic screen and a low resistance path for fault currents, it was decided to use a steel-cored aluminium earth conductor. This high-conductivity earth wire also eliminates danger to life owing to the earth resistance of individual towers being high. The vertical distance decided on as the minimum clearance between the lowest line conductor of the main grid and the earth is 22ft.—at 50 deg. Cent. Over buildings a minimum clearance of 12ft. is specified. The vertical distance between conductors has been fixed at 12ft. and the minimum clearance between live metal and the tower steel work under the worst conditions of line displacement will be 3ft. 6in. The average height for the main towers will be 70ft. for single circuits and 80ft. for double-circuit lines. The range of towers to be employed is set forth in the report. Transportation towers are included, and there is to be one complete rotation of the phases in each line section. As a rule the towers will be galvanised and the sections will be bolted together on site, but where necessary riveting and special rust-resisting steel and painting will be resorted to. At present rustless steels are too expensive to allow of using them for the construction of all the towers. The normal spans between the towers will be 900ft., so that, roughly speaking, there will be six towers to the mile.

In special circumstances non-standard towers will be used. The crossing of a large navigable river, for instance, is a separate engineering problem. In the first scheme to be considered by the Board it was necessary to provide for the crossing of the Clyde, the Forth and the Cart. The towers being used in these cases vary between 200ft. and 338ft. in height, and give a clearance at high water of 158ft. in the case of the Forth, 188ft. at the Cart crossing, and 228ft. at the crossing of the Clyde at Yoker. Standard conductors have been adhered to on the Clyde and Cart crossings, but on the Forth, where the span is 3050ft., special conductors, consisting of nineteen strands of galvanised steel wire, each 0·125in. in diameter, and eighteen aluminium strands of the same diameter, are being used. The type of foundation employed for the towers depends on the nature of the sub-soil encountered. The tower foundations at long river crossings are piled, but usually the concrete ball type, which is simple and inexpensive, is suitable for suspension towers. Where the ground is unsuitable

for exploding the holes or where heavy duty towers are required concrete foundations of the usual type are substituted. In the construction of these towers working loads have been assumed which are more severe than those called for in the recently revised regulations of the Electricity Commissioners. Consequently, it is permissible for the main transmission lines of the Board to cross roads or railways without any fundamental change from standard construction.

Atmospheric conditions in Great Britain, so far as range and rate of change of temperature are concerned, do not call for unusual precautions, but atmospheric pollution in some districts is very bad and in others the effects of foggy, salt-laden atmospheres have to be taken into account. The factor of safety of insulators is to be 2·5 when supporting the maximum working load under full normal voltage conditions. The normal maximum working load on the standard suspension insulator string will be 4000 lb. Insulators of the cap and pin type with ball and socket fittings have been adopted. Each insulator will be 10in. in diameter, and except at tension points, where one additional unit per string will be incorporated, there will be nine insulators to the string. Each chain is to be provided with a guard ring at the conductor end and arcing horns at the earthed end, the object being to prevent damage to line conductors, clamps and insulators in the event of flash-over and to equalise the voltages taken by the individual units of the insulator string. The mechanical strength of these rings and horns will be much greater than was at one time considered adequate, since light horns designed primarily to improve the potential distribution on the insulator string have proved quite inadequate for dealing with power arcs. The required maximum wet flash-over value of the standard string with arcing rings and horns will be 340,000 volts, the normal working voltage to earth being 76,000 volts.

Experience shows, the report states, that well-designed high-voltage overhead lines are remarkably free from trouble as compared with lower-voltage systems, but modern industrial conditions demand continuity of supply, and, to ensure it, selective protective gear must be installed on all interconnected systems. Pilot systems offer the best probability of obtaining rapid and sensitive discrimination, but on long lines their performance is less satisfactory and their cost would be prohibitive. Impedance or reactance relays offer the only alternative at present available. While, therefore, on the shorter interconnection lines it will be possible to make use of end balance protective systems, on the longer lines, say, 12 miles in route length, reliance will be placed on a system of definite impedance relays combined with impedance time relays, or on reactance relays capable of giving rapid and accurate discriminative protection. As lightning storms are comparatively infrequent it is not considered justifiable to incur the very high capital expenditure necessary to install lightning arresters. For protection against abnormal increases of potential due to lightning or to abrupt changes of load, reliance will be placed on the provision of a high-conductivity earth wire or arcing rings or horns on the reinforcement of transformer end turn insulation, and on the earthing of the neutral point.

Transforming stations giving duplicate supplies will be provided at each grid point. The types of transformers which are being used are dealt with by the report. At the most important stations the switching arrangements will be of the conventional type, one circuit breaker being provided for each transmission line and one for each transformer. The bus-bar sections will be in duplicate and there will be a circuit breaker for coupling the sections. At less important grid points a specially simple type of sub-station has been devised. In this type of station there will be only three 132,000-volt circuit breakers, one between line sections and one on each of the two transformers. This arrangement will reduce to a minimum the capital cost, ground area and number of vulnerable points. In certain cases, special switching arrangements are required, in others the restricted space available makes it necessary to introduce constructional features of particular kinds, and, in order to be able to meet such conditions, a range of designs has been prepared.

In all types of sub-stations the arrangements will be such as to allow for overhaul or inspection of any circuit breaker with the rest of the station in service. All 132,000-volt stations will be of the outdoor type. The decision to use outdoor apparatus was reached only after very careful investigation. Very substantial economic advantage is obtained by eliminating buildings; danger from explosion and fire is almost entirely removed and inspection is simplified. The 66,000-volt stations which will be erected in the London area will be of the indoor type.

A uniform standard of rupturing capacity of 1·5 million kilowatts has been adopted for all 66,000 and 132,000-volt circuit breakers. In all types of stations the circuit breakers, isolating and earthing switches are to be interlocked so as to reduce the probability of operation errors and thus safeguard the system and the operating engineers. Circuit breakers, both of the explosion pot and multi-break type, are being used.

Obituary.

SIR PERCY K. STOTHERT.

WE regret to have to announce the death of Sir Percy K. Stothert, which took place at Bath on Sunday last, May 5th.

Sir Percy, who was born on June 21st, 1863, was the third son of the late Mr. John Lum Stothert. He was educated at Clifton College, and after passing through an apprenticeship as a mechanical engineer he entered the service of Stothert and Pitt, Ltd., of Bath, becoming a director of that company in March, 1886. In 1902 he was appointed joint managing director with the late Mr. Walter Pitt, M. Inst. C.E., and in January, 1921, on the death of Mr. Pitt, he became chairman of the company, and held that position to the time of his death. He took a keen interest in the welfare of the firm, especially that of the staff and employees.

During the war Sir Percy was Chairman of the West of England Board of Management of the Ministry of Munitions, and in that capacity had charge of the arrangements of the visit of the King and Queen to Bath, Bristol and Wiltshire. It was in recognition of his services in connection with that Board that he was created a Knight of the Order of the British Empire in January, 1918. He was chairman of the Clevedon Gas and Water Companies, the Bath Gas Company, and was also on the board of the Bristol Gas Company. He was elected an Associate Member of the Institution of Civil Engineers in December, 1888, and was transferred to the class of Members in 1900. For several years he held a commission in the 1st Volunteer Battalion Somerset Light Infantry, and was also a member of the Somerset Territorial Army Association.

Literature.

Technical Data on Fuel. Edited by H. M. SPIERS. Published by the World Power Conference, 36, Kingsway, London, W.C. 2. Price 10s. 6d. net.

THIS handbook, of nearly 200 pages, was first issued in connection with the World Power Conference held in London last autumn, and under the auspices of the Technical Committee of that Conference. Its object is, clearly, to supply fuel technologists with useful data in concentrated form, but the success it will attain in this respect must depend largely upon what a fuel technologist is, and what he wants. One would think that coal would be of primary interest to him, but page 169 is reached before it is even mentioned, and then only in connection with the classification of fuels. Then follow ten pages almost exclusively on coal washing, though giving the optimistic information that the ash content of typical good commercial bituminous coals is less than 5 per cent., and that of typical coke less than 7 per cent., and we have come to the end of the information about coal. Not a word about methods of sampling, of making proximate or ultimate analyses, of carrying out calorimetric tests, of calculating the air required for combustion, of determining the composition of the waste gases, or, indeed, of most of the practical duties which fall to the lot of the combustion engineer. He is given, on the other hand, sixteen pages, mostly mathematical, concerning the flow of fluids in pipes, ten pages reprinted from another publication on pyrometry, twenty-three pages on heat transfer and conductivity, and thirteen pages of tables dealing with the properties of vapours, ranging from steam to propane, butane, and *iso*-butane.

The book contains very little information of direct use to the power station engineer. This is to be regarded as a general statement of fact rather than as a criticism. As exceptions to it should be mentioned the tables giving the properties of the gases concerned in the combustion of fuels, the properties and compositions of metals and alloys, the thermal conductivity of refractories, the softening points of Sezer cones, and, we may add, the very complete table of conversion factors. The book contains far too little to justify its title in some ways and considerably too much in others. It is stretching too widely the meaning of the word "fuel" to include the greater part of the contents, valuable as they may be in themselves, while this very comprehensiveness has been prejudicial to the inclusion of more data really pertinent to fuel. As regards the contents, such as they are, the information is authoritative and completely up to date. The book, however, bears throughout the stamp of the physicist rather than of the engineer, and it is difficult to make their points of view coincide. There is room for a new edition combining the merits of the present one with a fuller appreciation of what is needed and expected in a work purporting to give technical data on fuel.

BOOKS RECEIVED.

Leichtmetallkolben. By Prof. Dr.-Ing. Gabriel Becker. Berlin, W. 10: M. Krayn, Genthiner-strasse 39. Price 3 marks net.

Annales des Ponts et Chaussées, 1929. Fasc. I., Janvier-Février, (A) *Partie Administrative;* (B) *Partie Technique.* Paris: A. Dumas, 6, Rue de la Chaussée-d'Antin. 1929.

The Profession of Engineering. Essays edited by D. C. Jackson, jun., and W. P. Jones, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 7s. 6d. net.

Electrical Transmission and Distribution. Volumes V. and VI. Edited by R. O. Kapp, B.Sc. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. per volume.

The Measurement of the Discharge of the Nile Through the Sluices of the Aswan Dam: Final Conclusions and Tables of Results. By H. E. Hurst, M.A., D.Sc., &c., and D. A. F. Watt. Cairo: Publications Office, Government Press, Bûlâg. Price P.T. 10.

British Trade.

AT the annual meeting of the Federation of British Industries, the retiring President, Lord Ebbisham (George Rowland Blades) made a speech, from which we extract a few paragraphs.

"If it is true that something akin to an industrial revolution is in progress in our country and trade, this must equally be true of the other countries of the world. We must then remember that in copying such experiments as American mass-production methods, or Germany's system of cartellised control, we are dealing with what may be only passing phases in the industrial development of those countries. We must be careful not to imitate them too slavishly, and realise that our traditional lines of development have little in common with the lines of those countries. We may find that in the long run many of their business practices will prove to be unsuited to British conditions. We are, for example, frequently being exhorted to copy American selling practices, quite regardless of the fact that high-pressure sales campaigns, coupled with mass advertising in a closed market, are not readily adaptable to the needs of a small island, whose traditional outlet for her surplus products has been found in the catering for the highly diverse and specialised requirements of markets in every corner of the globe.

"Similarly, the problems which British manufacturers are called upon to solve, in connection with the reorganisation and rationalisation of their production and plant, to bring it into conformity with post-war requirements, are frequently very different from those which are the main pre-occupation of their principal foreign competitors on the Continent. For instance, no doubt certain sections of British industry require a cartel type of reorganisation similar to that which has so effectively helped Germany to deal with the problem of over-expanded capacity, but this may well be found inapplicable to British enterprise taken as a whole. The central quest to which British energies should be directed is the discovery of the quickest way of exploiting our acknowledged pre-eminence as the producers of high quality goods, and this seems to me to depend as much on a revival of our traditional spirit of initiative and adventurous enterprise as on learning the methods of organisation of other countries."

"As you are aware, the Union of South Africa recently concluded a Treaty with Germany by which Germany is to be granted the benefit of any future preferences granted by the Union to Great Britain. The Federation cannot but regret this as a serious breach in the walls of inter-imperial trade relations. We issued a carefully reasoned memorandum, which was widely reproduced in South Africa, pointing out the regret which we felt at this action on the part of the South African Government and our fears that it might have most unfortunate consequences on the trade between Great Britain and South Africa in both directions. Great Britain is South Africa's best customer, and the main source from which she draws the supplies of capital necessary to develop her resources, and, at a time when so much is being done in Great Britain to foster the idea of buying Empire products and amongst them South African products, it does seem unfortunate that a step should have been taken which cannot fail to have an unfortunate reaction in this country.

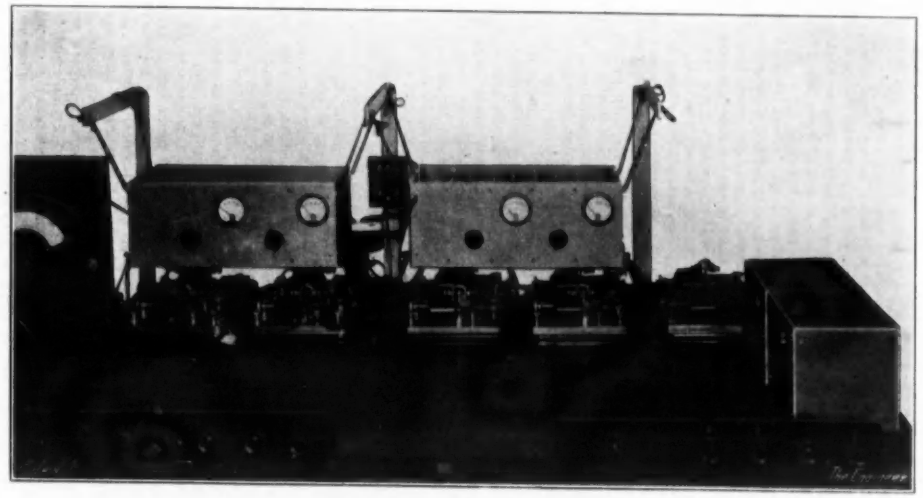
"A second point to which I would draw your attention is the legislation recently passed in Canada laying down that United Kingdom goods, in order to enjoy the benefits of the British preferential rate under the Canadian Tariff, must be 50 per cent. British as to raw material and/or labour. We recognise that the desire of the Canadian Government in this matter is to help British manufacturers by confining the benefits of the British preferential rate to products which are essentially British. At the same time there are many borderline cases in which it is practically impossible to comply with the requirements of the new Canadian legislation, owing to the fact that the raw material in question either does not exist at all within the British Empire, or, at any rate, does not exist in commercial quantities. There are certain other ancillary difficulties into which I do not propose to go at the moment. The Federation has been in close touch with the Canadian authorities in this matter, and I feel sure that we may count upon a sympathetic consideration of our views. So great is the importance which certain members attach to this question, that we have decided to send the head of our Empire organisation to Canada in the near future, in order to discuss personally with the Canadian Government the aspects of this question which are presenting such a difficulty to some of our members.

"Finally, I would refer for one moment to the question of trade between this country and Spain. The effect of the Spanish tariff upon British trade and the uncertainty as to the future policy of the Spanish Government have received careful consideration. I am glad to say that the Spanish Government have agreed to receive a small deputation from the Federation in order to discuss this question and others connected with trade between our two countries, and I think that you will agree that the Federation is performing a useful task in the interests of British industry in sending this deputation to Spain to go into matters on the spot. I trust that the result of their conversations with the Spanish Government will be to ease the commercial relations between the two countries."

EQUIPMENT FOR DETECTING FLAWS IN RAILS

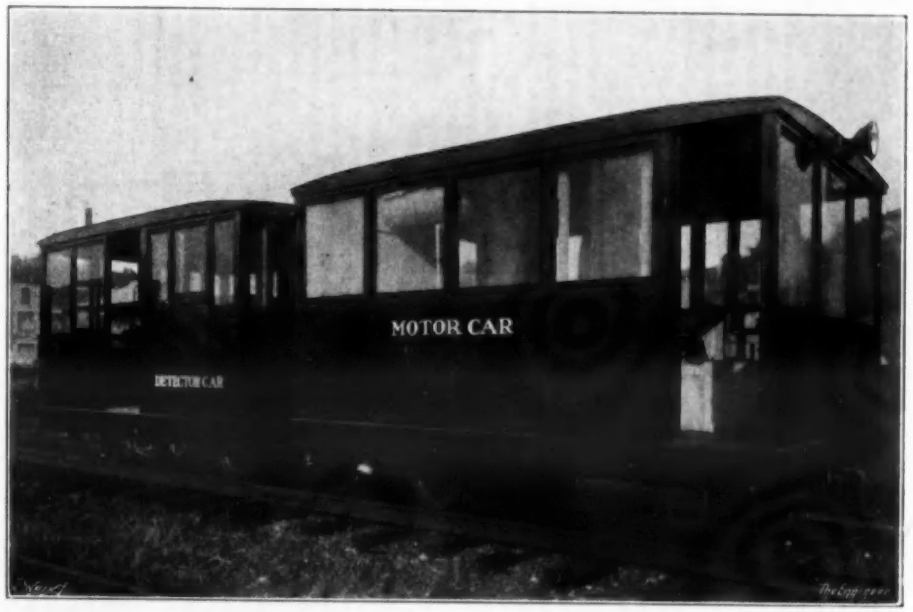
THE SPERRY RAIL SERVICE CORPORATION, CHICAGO, ENGINEERS

(For description see opposite page)



RELAY AND AMPLIFIER TABLE

BRUSH EQUIPMENT AND PAINT SPRAY



DETECTOR CAR AND RAIL MOTOR CAR

THE FIRST DETECTOR CAR IN SERVICE

The Detection of Flaws in Rails.

VARIOUS methods and devices have been proposed for detecting transverse fissures and other flaws in rails during their service in tracks. The proposals have covered the use of X-ray, magnetic and electric devices. The X-ray method is primarily a laboratory one, applicable to thin plates and sections, and as a means of discovering internal flaws in the thick mass of steel composing a rail head is at present scarcely practicable. Several devices of the magnetic type have been evolved. They depend for their action on the well-known fact that the magnetic permeability of steel is influenced by very slight changes in its chemical composition, by the presence of slag, voids and so forth, by the mechanical and heat treatment which the steel has received and by the state of stress to which the metal is subjected at the time of observation. The devices of this kind that have been tried seek to detect the existence of transverse fissures by measuring the total magnetic flux within the rail or the leakage flux which passes through the air adjacent to the rail. While this method of attacking the problem has attracted several investigators, it is commonly held to be unsatisfactory, because of the similarity of effect produced by a multitude of factors in addition to that the detection of which is sought, and because of the consequent difficulty of correctly interpreting the results.

The only device of the electric type with which we are at present acquainted is that recently developed by Mr. E. A. Sperry—the inventor of the Sperry gyroscopic compass, &c.—and now being applied in practice by the Sperry Rail Service Corporation of Chicago. Mr. Sperry began his investigations of the subject by considering the possibility of using alternating current, alternating magnetism, direct current, and direct magnetism. He was at once led to eliminate alternating current or magnetism because the effect produced by either of these agencies was confined to the surface and would fail to reveal the state of the internal structure. Next, he was forced to discard the use of direct magnetism because of the fact that the permeability of steel decreases with the hardness. Modern hard rails have, he found, a very low permeability. In fact, in some heat-treated and quenched manganese steel rails the magnetic permeability falls practically to zero.

Direct current alone was left as a means of solving the problem. The conception to which Mr. Sperry directed his attention covered the passing of a fairly heavy current

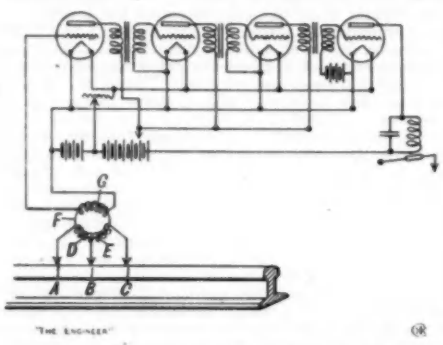


FIG. 1—SPERRY FLAW DETECTOR SYSTEM

through the rail under examination and the investigation of the resulting reactions. If the specimen were sound and homogeneous, the flow of current would be uniform and unobstructed, but if there were a flaw, such as an inclusion, crack, fissure or other discontinuity, the flow would be altered and the difference would vary with the kind and size of the obstruction. The advantages foreseen for the direct-current method were that the amount of energy that might be employed was not limited by any saturation or other effect, and that the variation in the degree of energisation that could be produced would extend the range of determination covered by the method.

One of the difficulties which were foreseen was that involved in neutralising inevitable variations, large or small, in the energising current, and thereby eliminating false indications. The general principle of the method adopted is indicated in Fig. 1. Two brushes, not shown in the diagram, are placed in contact with the track and between them the energising current is caused to flow. Midway between these two brushes are the three searching brushes A B C, which are connected to two coils D E, constituting the primary of a transformer F. The coils D E are oppositely wound and produce opposite magnetic excitation of the transformer. Any variation which may occur in the energising current will be picked up by the two outer brushes A C, but the influence of such variation will be neutralised as regards the current induced in the secondary G of the transformer. If, as the brushes pass along the track, a fissure is encountered, then while the fissure is between the brushes A B the coil D will be excited to a greater extent than the coil E. The transformer as a consequence will become active, and in the secondary G there will be induced half—say the positive half—of a sine wave. As the fissure immediately afterwards is passed over by the brushes B C, the secondary is excited in an opposite sense, and the alternating wave induced in it is completed by the addition of the negative half. The completed wave is passed to an amplifier, by which it may be examined as to its magnitude and characteristics.

After prolonged laboratory tests, it was ultimately found possible to detect by means of the apparatus flaws or defects representing as little as one-tenth of 1 per cent. of the area of the rail head. Further means were developed for discovering and analysing the departure from axial flow of the current produced by the defect, and so of determining the size, characteristic, and exact position of the fissure or other flaw. It was also found that the system was equally applicable to non-ferrous metals.

A complete equipment was next erected at a rail rolling mill and a batch of a thousand rails passed through it. All defects previously noted by the inspectors and many others that had not been noticed or had been passed as unobjectionable by the inspectors were discovered and recorded. Many of the defects were merely surface abrasions or cracks. It was found that the results were not in the slightest affected by the repeated handling of the rails by means of a magnetic lifter.

In the final stage of development the apparatus has been mounted on a standard track maintenance trailer car which is coupled to a power car. The operating speed is 5 miles an hour or more. The detector car is equipped with a 25 horse-power engine directly connected to a 4000-ampère, 2-volt generator, running at 900 r.p.m. The four-valve amplifier has a magnification factor of two to three hundred thousand. The amplified current is employed to operate ten relays. One of these relays controls the release of a spray of white paint, which is ejected against the side of the rail whenever a defect is found. On a moving strip of paper seven pens are arranged to draw lines, three pens for each rail, and the seventh to mark the rail joints. If the break of continuity at a defect is small, one pen only operates by drawing a short transverse line. If the discontinuity is of medium size, two of the pens operate. If it is large, all three pens make marks on the chart. The three "fissure" pens are automatically thrown out of circuit when the pen marking the rail joints operates. A numbering machine is employed to identify each rail on the record. Rotary scratch brushes

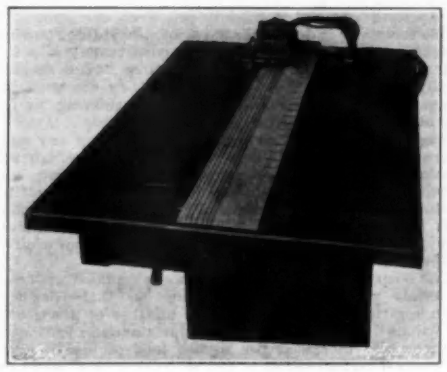


FIG. 2—RECORDING PENS AND CHART

are placed ahead of the front contact brushes to remove rust or foreign material from the running surface of the rail, so as to ensure good contact. A buzzer in the car is operated by another of the relays, and provides a check on the proper action of the apparatus.

The detector, it is claimed, discovers not only fissures and other discontinuities in the rails over which the car passes, but also any chemical or metallurgical changes in the metal. It can be adjusted to ignore the second-named set of differences, and to concentrate on the first. In addition to its detecting capabilities, the apparatus is claimed to have, as a by-product as it were, a definite advantageous effect on the rails on which it is used. The flow of electricity in the rail produces powerful magnetising forces which are developed suddenly. The effect stated to be produced is the release of internal strain in the rail and the ageing, seasoning and toughening of the metal without affecting its hardness.

In 1927 about 5000 rails in the United States broke as a consequence of the existence of fissures in them. When one rail breaks by reason of a fissure, it is the practice—and in some States legally compulsory—to remove from the track all the rails from the same heat. According to Mr. Sperry, this practice is much too drastic. Experience obtained with his detector car suggests, he states, that from 90 to 95 per cent. of the rails might safely be allowed to remain in service.

On page 522 we illustrate the first car built by the Sperry Corporation for the American Railway Engineering Association, and also a later example coupled to a rail motor car. On the same page a photograph is reproduced showing the brush equipment and paint spray of the detector car and another one illustrating the relay and amplifier table.

Blast-furnace Plant and Practice.*

FOREWORD.

DEVELOPMENTS in blast-furnace practice and plant during recent years have been rather in the direction of details of design and refinements in the application of principles and features already adopted as standard practice, than in the adoption of any new principles or methods, either of a radical or semi-radical nature.

In general, the trend in the United States is in the direction of larger, and still larger, furnaces with ever-increasing output capacities, from which, together with improved details in methods and equipment, and attention to details of management, considerable progress in economy of production has been attained, both in fuel consumption and in other items of production costs; whereas in Germany the attainment of similar ends has been sought by careful attention to the selection and preparation of materials, by sizing or sintering their ores, and sizing and screening limestone and coke, thus obtaining, through the greater permeability of the furnace charge and consequent economical increase in rate and efficiency of operation, improved economy of production and increased output per unit of hearth area.

Practically all those features, constituting more or less recent improvements in details, upon which the Committee has thus far been able to obtain information, as such as have been already referred to in the "Proceedings" of technical societies or in the technical Press. The Committee, therefore, finds some difficulty in its search for any novel advance or general improvement in modern blast-furnace practice and plant, and is of opinion that in order to ascertain what, if any, more recent and as yet unpublished improvements may have been adopted in this field, and to obtain any information relative to them, it would be necessary to appoint a small body of qualified investigators, who should be authorised to make visits to the more advanced iron-producing districts, at home and abroad, for the purpose of gathering new information and of formulating a report thereon.

For the present, and pending any further information which may be obtainable by the means above suggested, the Committee has prepared, and presents herewith, a report outlining the various features of modern blast-furnace practice and plant, with short comments thereon, and with references to some of the more recent methods devised for applying the principles, and attaining the purposes, aimed at under these headings.

The Committee fully recognises that this report contains little, if any, information which has not previously been available from other sources to those who are interested, and endeavour to keep themselves acquainted with the technical progress made in the iron industry; on the other hand, further emphasis will have been laid upon the importance, from the competitive standpoint, of the adoption of modern blast-furnace practice and plant by those who have not adopted those economic features which have become practically standard among their competitors.

In dealing with features pertaining to blast-furnace practice, and any recommendations bearing thereon, it is to be understood that they refer to that practice which includes the operation of each furnace, in any group of furnaces constituting a blast-furnace plant, as an individual unit; and that each furnace is blown with a definite and regular volume or weight of blast per minute, irrespective of variations in pressure due to varying conditions within the blast-furnace.

(The modern tendency towards the provision of the greatest possible uniformity in all materials and conditions affecting blast-furnace operation has led, as a further step in that direction, to the adjustment of the volume of blast blown, by periodic variation of the volume to allow for changes in atmospheric temperature, humidity, and pressure, for the purpose of providing the furnace with as regular as possible a weight of oxygen in the volume of blast supplied per minute.

This practice tends to minimise these irregularities in the rate of driving, and in quantitative reactions, which accompany the variations in the oxygen content per cubic foot of a constant blast volume, due to changes of temperature, humidity, and pressure in the natural atmosphere which are so marked between daytime and night, and, at times, from hour to hour.)

With modern blast-furnace practice and plant it is considered that the following three objects are those which it is desired to attain:—

(1) Regularity in that quality of product required for the time being;
(2) Maximum economy of production; and
(3) Maximum output per unit of time;

the importance of these objects being in the order in which they are named.

With modern blast-furnace plant and practice the various features involved therein are so interwoven in their effect that it is their composite result which must be considered as producing the highest degree of efficiency in each of these aims—*i.e.*, that the adoption of no one of the features of modern practice and plant is sufficient in itself to yield the most satisfactory results in that direction which appears to be the particular function of that feature; in fact, as has been too often experienced, such adoption may yield very little, if any, material improvement.

The various factors entering into the subject under consideration may be enumerated as follows:—

Selection of raw materials.
Preparation of materials.
Mechanical handling of materials.
Furnace charging and top distribution.
Furnace lines (interior).
Hot-blast stoves.
Gas cleaning.
Gas burning and surplus gas.
Blowing plant.
Power plant.
Dry blast.
Pig iron casting.
General lay-out of plant.
Use of recording instruments in connection with the operation of the blast-furnace.
Oxygen enrichment of blast.

SELECTION OF RAW MATERIALS.

In selecting material for blast-furnace use, the quality as determined by chemical analysis, is of considerable importance, and has necessarily a direct and marked influence upon the results obtained, and even upon the design of the plant to obtain them. Local and commercial considerations, however, are always vital factors in this connection, and such considerations alone decide whether the cost of material of higher grade may outweigh the advantages of its use, or, conversely, whether it is worth while suffering the drawbacks connected with the use of low-grade material which can be delivered to the furnaces at a low cost. Hence it is extremely difficult to be definite upon questions of quality, and it is only proposed to deal with the matter on broad lines.

The general opinion of those operating blast-furnaces undoubtedly favours strong coke of open texture. Although there are odd exceptions, it is a general rule that as the ash in coke increases beyond 10 per cent. the coke shows an increased tendency to brittleness, and, on this account, its general character is liable to fall below the best standard. Where the selection of fuel is practicable, this point should be borne in mind. It is, moreover, generally accepted that in the case of all furnaces, excepting possibly those using particularly high yielding ores, an increase of 1 per cent. of ash in round figures is equal to a 2 per cent. decrease in coke value, due to the

* Iron and Steel Institute. May, 1929. First report by Committee No. 2 of the Iron and Steel Institute. The Committee is constituted as follows:—Messrs. A. K. Reece (chairman), G. Barrett, A. Crooke, E. H. Lewis, P. List, D. E. Roberts, and H. E. Wright.

necessity of melting the ash which has replaced 1 per cent. of carbon in the coke.

The practical point of view upon a more indefinite question—namely, that characteristic which has been termed the reactivity of coke to carbonic acid—is that the loss of carbon by such reactivity in the upper portion of the furnace, where carbonic acid exists in large proportions in the gases, may counterbalance any virtue such coke may have by reason of its combustive reactivity on reaching tuyere level. Practical experience also indicates that, in its descent of the furnace, the reactivity of the coke is somewhat affected by carbon deposition, which makes it at least doubtful whether tests on the reactive quality of coke as charged have any direct bearing on the state of the same coke when it reaches the lower combustive area. The research which is being made into coke quality by the various coke research committees may with advantage be encouraged until knowledge upon this and other points is more definite.

In regard to selection of ore by analysis, &c., there is every indication that the better blast-furnace results are associated more with high yielding—and more especially with high yielding, easily reducible ores—than with low-yielding varieties. On the other hand, where furnaces use ores of indifferent quality the results are almost invariably more or less comparatively disappointing. Where selection is possible, it will be conducive to best results on any plant to select those ores of the highest degree of purity by analysis that are available. The substitution of inferior ores almost invariably tends to increase the fuel used per ton of pig, with the attendant disadvantages. The selection of ores by analysis thus has an important bearing on furnace operation. To mention one point only, the iron content of the burden decides the amount of material it is necessary to pass through the furnace to produce 1 ton of iron, and, obviously, for output the less there is the better. Any increase of fuel means a larger *pro rata* volume of air to be blown for each ton of output, and there is a reflex action on the power of the blowing engines, number of stoves necessary, size of hearth for given output, and other important items.

Thus, with inferior ores the difficulties adversely affecting large outputs and low fuel consumptions increase and become cumulative, and possibly where modern blast-furnace plant is installed the disproportion between the relative value of high yielding and low yielding iron ores is increased.

Another point of importance in this connection is the necessity for a definite degree of uniformity, within fairly narrow limits, in the quality of ore, coke, and limestone.

Although it is, of course, true that, where fuel consumption per ton of pig iron is high, most of the potential value of the excess used still exists in the furnace gases, and can be realised by fully utilising them, this is only a partial saving clause, and does not remove the drawbacks already mentioned.

Whilst published blast-furnace returns show that high-yielding ores do not invariably give the best results, nor low-yielding ores the worst, and also having due regard to the importance of commercial and local considerations, in general the evidence distinctly shows that the quality of material used as determined by analysis is a factor of primary importance in its influence upon blast-furnace operation and results.

The selection of limestone is usually a commercial question, though obviously the purer the stone the more economical is its use in the furnace.

Preparation of Materials.

The great importance of preparing ores, and limestone or other fluxing agents, by bringing them to more uniform sizes than those in which they are mined or quarried—1in. to 4in. for ores and 4in. to 6in. for flux—by crushing the lumps and by sintering or briquetting the fines, in order to increase and render more uniform the possible rate of reduction and to ensure greater uniformity in their distribution in the furnace throat, has been emphasised in published papers, in experimental investigation and in actual practice; but the Committee wishes to emphasise further the vital importance of this practice. Its beneficial effect upon regularity of operation, fuel economy and output is unquestionable, and in modern practice for large economical outputs it is an essential feature.

The detrimental effect of an excessive proportion of fine ore in an ore mixture upon furnace operation is well known. While modern design and practice have considerably reduced the difficulty of smelting fine ores, the excessive losses from flue dust still remain an important factor in connection with their use.

The very considerable losses of ore in the form of flue dust, which are practically unavoidable in the fast-driven modern blast-furnace plant when the ore mixture contains any material proportion of fine ore, has led to the adoption of methods of recovery by treating the dust to convert it into a physical condition suitable for recharging into the furnace. Many attempts have been made previously to recharge the coarser dust after wetting, but the results of this practice have generally been unsatisfactory.

Of recent years, in modern practice, the satisfactory recovery of this material has been attained by converting it into sinter by one or other of the well-known sintering processes, either alone or after mixing with other fine ores. This practice is now considered "standard" in Germany and the United States.

An economic feature of this practice is the fact that flue dust usually contains sufficient coke dust to permit of sintering without adding fuel, the amount of the latter being frequently sufficient to provide fuel, not only for the ore in the dust, but for a proportion of added ore as well.

(In Germany, blowing flue dust into the furnace through holes in the upper stack, as a method of charging it without danger of its being redischarged into the gas flues, is practised in at least one locality, with claimed success; but no information is available as to the economic value of this practice as compared to recovery by sintering. It may be said that this method has the disadvantage of forcing the fine coke in the dust into the furnace as well as the iron-bearing dust, whereas this coke dust would doubtless have a much greater value as fuel in the sintering process.)

The principles upon which the importance of the preparation of ores and limestone, above outlined, is based, apply also to the fuel—coke—used in the blast-furnace.

Coke of large size presents a comparatively smaller surface area to the free action of the oxidising gases, and has a relatively retarding effect upon the total time for complete gasification. Also, the wider the difference between the size of the smaller and the larger lumps, the less uniform the mechanical distribution, and the reactions, in the furnace.

While definite practice in the sizing of coke cannot be said to have become general in modern practice, there is a tendency in this direction, and very large coke is generally deprecated, and, where possible, avoided. Where applied, this practice has proved of advantage in its tendency toward greater regularity in furnace operation; in fact, at one plant in Germany the coke is crushed to 2½in. sizes under 1½in. being screened out, with such good results that other plants are also adopting this practice; and a furnace in the United States is working satisfactorily on crushed coke, a screen test of which, as loaded into the skip tubs at the furnace, is stated to be as follows:—

	Per cent.
On 2in.	17·90
„ 1½in.	41·78
„ 1in.	27·80
Through 1in.	12·52

On the other hand, small coke, up to the size of breeze, is generally considered objectionable for reasons similar to those applying to fine ores, and owing to its inefficiency as a blast-furnace fuel. Therefore, the practice of passing the coke over screens to remove the breeze, up to about 1in. and even 1½in. in size, when a good market exists for small coke, has been found highly economical and has become quite general in modern practice.

The screening is done over fixed, or, preferably, moving screens as the coke passes from the coke bunker into the charging skip or bucket, the screenings being mechanically loaded into railway wagons. They are used for steam raising at boilers, as fuel for ore sintering, or for any other purpose for which they are suitable.

Screening out the fines from ores containing any considerable proportion of them, when passing through the crushing plant, or from ores not requiring crushing, and treating them by the well-known sintering or briquetting methods, is an effective means of removing the objectionable features of smelting fine ores in the blast-furnace, and is a continually increasing factor in the preparation of materials.

The output capacity of blast-furnaces supplied with raw materials properly sized according to their density, including the elimination from the mixture of practically all "fines" by the use of the methods above mentioned, is materially increased per square foot of hearth area, with improved fuel economy, *i.e.*, with furnaces of moderate hearth diameters and total volume charged with materials so prepared, the output capacities are equal to furnaces with considerably greater hearth diameters and volumes operated with materials not so prepared, and with reduced production and construction costs in economic excess over the cost of such preparation of materials.

Such results are entirely consistent with the greater regularity of operation—more uniform action throughout every cross-section of the furnace—and with the reduction to a minimum of the "flue dust" losses.

The physical characteristics of the ores to be crushed must be taken into consideration in determining the method of crushing most suitable in each case.

With ores of a friable nature, in the crushing of which there is a tendency to produce "fines," progressive crushing, as with the Blake jaw, Gates rotary, or revolving disc types, is not suitable, and the high-speed rolls type is indicated. With the latter the crushing operation is practically instantaneous, and repeated abrasions between the pieces of ore is reduced to a minimum. The latter type is also more suitable for ores having the slightest tendency to agglomerate under pressure.

Practically all of the usual methods which have been developed for rock crushing are applicable to iron ores.

The type and lay-out of plant suitable for any particular case are determinable by local conditions, as no definite type or lay-out is especially suitable for iron ores.

With ores containing fines and rubble, screens for separating the lumps which need crushing should be provided, and where further treatment of the fines is advisable, screens should be provided for separating them from the rubble. Owing to the heavy duty, all plant must be of very substantial construction to ensure durability and efficiency, and capacity should include a considerable margin above the normally required output.

Mechanical Handling of Materials.

High wages for manual labour, together with the large quantities of raw materials required per unit of time with modern plant and practice, have necessitated the installation of mechanical means of handling these materials and the products. The old policy of "the smallest capital outlay per ton of product" has given place to "the greatest output per man employed." The latter policy can only be carried out by the installation of mechanical appliances. In modern plant manual labour is almost restricted to the manipulation of levers, thus replacing large numbers of men specialising in physique without the necessity for intelligence, by a few men of intelligence without the necessity for physique.

The general features of a mechanically operated blast-furnace plant are too well known to require description, and the details of specific designs are too varied for inclusion in this report, different types being fairly well standardised and each having its advocates. Suffice it to say, that under existing severe economic competition mechanical handling in practically every branch of blast-furnace operation is essential in modern practice.

This factor has reached, in some recent equipment, what may be considered practically the limit in labour economy, insomuch that one man only is required to control and carry on the entire charging of large-capacity blast-furnaces. Each cycle of operations is started and carried out to completion in proper sequence automatically by a system of electric controls set in operation by the throwing of a single switch by the operator, without further attention. Overlapping through error on the part of the single operator is safeguarded by interlocking devices.

Of further economic importance is the mechanical handling of raw materials from mines or quarries, the delivery into railway wagons and into ships at loading ports, and the discharge from ships into railway wagons at receiving ports, or into stock at works, of sea-borne materials.

Facilities for these purposes include storage bunkers at the mines and shipping ports, from which the materials are discharged by gravity direct into self-discharging railway wagons of large capacity and/or into specially designed ships, the decks of which consist almost entirely of hatches, for rapid and complete unloading by means of large-capacity grab unloaders, such as the well-known Hulett or other types.

By these means very considerable economies are effected in loading, unloading, deck dues, and demurrage charges, and also in the time-service capacity of transport vehicles, both wagons and ships.

So many and varied, in both general arrangements and details, are the methods employed, and so varied are the opinions respecting them, that no particular method may be singled out as warranting special recommendation as the most efficient or economical.

Furnace Charging and Top Distribution.

In modern mechanically operated blast-furnace plants, charging and top-distributing devices are distinguished by two types in general, each characteristic in its method of dealing with the materials. Under these headings are the inclined and the vertical-horizontal hoisting bucket-charging system, and the inclined hoisting skip-charging system.

Each of these systems provides for the equal distribution of the materials around the main charging bell; the former by a central discharge over the bell from the bottom of the bucket, and the latter by charging, by means of a tilting skip, through a preliminary distributing small bell and hopper equipment, which is automatically revolved through any selected arc after each skip load is tipped into it, thus assuring equal distribution around the main charging bell.

On the Continent the former has been the most generally adopted type, while in the United States the latter is more generally used. The former may be designated as the method for handling large quantities slowly, and the latter as the method for handling small quantities quickly. Each is effective, and each has its advocates who claim the superiority of the one over the other in specific respects. Some such device, however, is a necessary accompaniment of modern mechanically operated blast-furnace plant. Many other arrangements have been brought out for assuring equality of distribution on the large charging bell, but the two systems above mentioned have become practically standardised.

In modern blast-furnace practice, too great emphasis cannot be laid upon the importance of the distribution of the raw materials within the furnace top. The wider the variation in the sizes of the components of any particular raw material, the less the uniformity of distribution of that material, and *vice versâ*. Hence the importance, from this standpoint alone, of the preparation of the materials referred to.

The prevailing practice in charging the ore burden, when coarse and fine ores are in use, is to mix a proportion of each grade in each charge in order that the charges may be as uniform in mechanical characteristics as possible; but there have been recently published some very interesting results from a furnace in the United States, using a very dense ore crushed to 1½in. and under and screened into three sizes, designated as "coarse," "medium," and "fine."

By charging the three sizes in layers, each charge consisting of one size only, very considerable improvement in fuel consumption and in other operating conditions was obtained compared with the results from the previous practice of crushing to 3in. and under and screening into two sizes, viz., over and under ¾in.

While it is quite possible that the characteristics of the ore in this case, particularly its density, may have a definite bearing upon the improved results obtained through the change in practice adopted, it cannot fail to have a very strong significance as evidence on the general question of the preparation of materials for blast-furnace use.

Great importance is attached to the angular discharge from, and to the diameter of, the main charging bell, in relation to the furnace throat diameter, the difference between these respective diameters being usually about 4ft., with some degree of variation according to the mechanical condition of the ore mixture.

A further important factor in distribution is the size of the coke unit per round of charge. The tendency in modern practice has been towards an increase in this unit, one of the objects being to keep ore and coke as much as possible out of direct contact in the upper reducing zone, in order to restrict to a minimum the direct reduction of iron oxide by solid carbon in that region. Units as large as 6 and 7 tons have been used with satisfactory results in furnaces with moderate throat diameters.

Furnace Lines (Interior).

Developments in blast-furnace practice as regards interior design or lines have been the outcome of efforts towards an improvement in operating regularity and increase in output per furnace consistent with quality and economy. Efforts towards the attainment of these objects at first took the direction of great height and large interior volume, but the results of this line of development did not prove satisfactory. Following this phase, development took a direction which led to what may now be designated modern design. The distinctive characteristics, as compared with those of less modern design, are the larger hearth diameters, the low bosh, and the narrower shafts, the hearth diameter controlling, within fairly narrow limits, the other dimensions.

The latest developments in blast-furnace interior lines are towards still larger hearth diameters and relatively smaller bosh and throat diameters. There are furnaces now in operation in the United States having hearth diameters of 24ft., 24ft. 6in., and 27ft., bosh diameters of 27ft. 6in., 26ft. 3in., and 28ft. 6in., and throat diameters of 18ft., 17ft., and 18ft. respectively. It is understood that the dimensions of the latter will be repeated in the next relining, which would seem to indicate that the results from this "super-furnace," have been entirely satisfactory. It is, therefore, questionable whether the limits in size and output have yet been reached with the now established monthly record of over 1000 tons per day, and what will

be the factor establishing that limit when it is reached.

A limiting factor to much further expansion in this direction appears, however, in a relative increase in throat diameter, and in consequent bell diameter, in its bearing upon top distribution.

This limitation, on the other hand, may be overcome by a more uniform sizing of materials, as the less the difference in size between the smallest and the largest particles in the charge, the less important is the question of top distribution; and the undesirable increase, through the use of larger bells, in the difference between the height of the stock column near the walls and the centre may be overcome by some improved method of distribution in the furnace top.

Hot-blast Stoves.

Cleaned gas having become standard practice, the modern hot-blast stove is designed with small checker openings, and in overall dimensions has become fairly well standardised with a comparatively small diameter, 18ft. to 22ft., and increased height 90ft. to 110ft. Owing to the higher blast pressures, much stronger shell construction is required than formerly. In internal design the two-pass Cowper type has practically displaced other alternative types; but a departure from the usual arrangement—internal combustion chamber—has been made in some stove installations with outside combustion chambers, which, it is claimed, give better distribution of air and gas, and eliminate the stresses on the brickwork.

Interior construction, including checker bearers and supporting columns, is wholly of fire-brick, though a recent return to the use of castings in the bottom construction instead of brick piers, arches and transverse tiles is reported, the castings being, however, of a special heat and oxidation-resisting quality. Checker openings are 3¼in. to 5in. square, 4in. to 4¼in. square being representative of general practice with bricks 2¼in. to 3in. in thickness.

Efforts to improve checker construction are indicated by new designs brought out now and then, among which may be mentioned two cases of recent installation. One has round and square checker openings of 4¾in., with 2¾in. to 1⅛in. diagonal inserts put into the checker openings, thus increasing the heating surface; the other has blocks perforated by seven holes 1·89in. in diameter, or nineteen holes 1·77in. in diameter. In some cases the upper halves of old stoves have been relined, with advantage, with the latter types of blocks. Higher efficiencies with lower stack temperatures are claimed for these constructions.

Shaped checker bricks are much less generally used than formerly, ordinary 9in. bricks being largely used in checker construction, though there has been some return to the former.

In this connection, however, may be mentioned a recently introduced system of construction in the checker section of hot-blast stoves, by the use of which definite checker flues are replaced, or partly replaced, by short spiral-shaped bricks.

Stoves of this construction, in use at the Ilsede Ironworks, Gross-Ilsede, Germany, are reported to give results very superior to those from stoves of the usual checker flue construction.

Recent progress with hot-blast stoves is more particularly in the direction of improvements in gas burner design for economy in combustion. A number of new designs of gas burners have been brought out during late years, chief among which are the pressure burners with automatic control of the gas and air mixture, the unit system of fans for air supply being preferred. Some systems embodying this type are the Steinbart system in the United States, and the Weyman system, of British origin. In Germany the P.S.S.—Pfoser-Strack-Stumm—system of gas burning in hot-blast stoves, in which the air is delivered at high velocity into the gas stream, is also growing in favour.

By these improved methods it is claimed that, due to the much higher efficiency obtained, fewer stoves or less total heating surface per furnace are required. This may be considered one of the principal objects to be attained through increased efficiency in stove gas combustion, another being, of course, the saving of gas for other purposes.

Greater attention is also being paid to the insulation between the stove linings and shell by means of special insulating material.

In hot-blast, cold-blast and chimney valves, more or less standard designs prevail. For the first-named, the gate and the mushroom types are used, with water-cooled seats and valves of phosphor bronze and cast steel bodies. In cold-blast valves, the sluice valve type of gate valve, vertical or horizontal, with cast steel bodies and operated by rack and pinion, is most usual. In chimney valves the spectacle type is much used, though the removable type, similar to the pull-back gas valve arrangement, is also favoured. Recently a new type, similar in design to the flap check valve, has been brought out.

The adoption of two outlets for the waste gases from the stoves, for the purpose of improving the distribution of the gases through the checkers, is a feature in stove construction which, while not new, is increasing in use. Distant and automatic control of stove changing is a recent innovation in stove operation.

There has been no radical or recent alteration in general practice in these respects, though there are variations in the details in different designs.

Gas Cleaning.

Three distinct systems of gas cleaning are now in vogue:

(1) Dry filtration, represented by the well-known Halberg-Beth type.

(2) Water-spray washing, represented by the static spray washer, largely used, especially in the United States of America, and the mechanical disintegrator or fan type, largely used, especially in Germany and in this country.

(3) Electric deposition, represented by the Lodge and the Cottrell—now combined—and the Lurgi and the Elga.

The disposal of the dust in the form of sludge, and the pollution of the washing water with No. 2, are bothersome under some conditions. For the prevention of the deposition of fine wet sludge and water—carried over by the washed gases—into the gas mains, previously an objectionable feature, supplementary heating of the washed gases to a sufficient degree to vaporise the entrained moisture and dry the fine sludge, for which a temperature rise of 30 deg. to 50 deg. Fah. is claimed to be sufficient, has recently been introduced in the United States. The apparatus is a heat interchanger, constructed on the principle of the tubular boiler, the heating medium being the waste gases from the hot-blast stoves. The washed gas passes through the tubes and the waste gases through the body of the interchanger. Provision is made for periodic cleaning of the tubes in nests of a few tubes each without interruption of operations or material reduction in efficiency. This supplementary heating is said to have proved satisfactory and economical, in which case the static wet system of cleaning has the recommendation of simplicity and ease of operation. This system, except when supplemented by Theisen or other mechanical washers, is only suitable for cleaning gas for heating hot-blast stoves, boilers, and some other heating purposes—*i.e.*, what is generally designated "rough cleaning." There appears, however, to be a tendency, particularly with stoves having very small checker openings, towards secondary cleaning by disintegrating washers or electric precipitation, indicating a growing recognition that a higher degree of gas cleanliness in such cases is necessary and more economical in gas consumption.

Preheating of air and gas, and also of blast, before they enter the stoves, by the utilisation of the heat in the waste gases from the stoves, or in the raw hot gases from the furnace, are steps towards further economy which have been reported in several installations. Increases of 270 deg. Fah. in the blast temperature, and 90 deg. Fah. in the gas temperature, before entering the stove, are said to have been obtained.

No. 1 system is suitable for cleaning gas to that high degree required for use in internal combustion engines.

Gas Burning and Surplus Gas.

Much attention has been given of late to efficiency and consequent economy in the combustion of blast-furnace gas in hot-blast stoves, boilers, &c.—to which reference has been made under hot-blast stoves—by systems of automatic regulation of the gas and air mixture, some of which are proving highly efficient in blast heating and power production, thus increasing considerably the quantity of surplus gas available for purposes other than the blast-furnace plant requirements, such as the generation of electric current for steel works operation, and for sale to local communities and industries; for open-hearth and other heating purposes with or without the admixture of coke oven gas when available; for coke oven heating, thus setting free the richer coke oven gas for other purposes, as mentioned above, and for sale to gas companies for lighting and heating in neighbouring communities.

Valuable returns are thus obtained for credit to the pig iron production costs.

Blowing Plant.

In modern blast-furnace plant the blast-furnace gas-driven reciprocating engine and blower, and the steam turbine-driven turbo-blower, are the two types of blowers now almost universally installed.

The gas-driven blower, developed in Germany, has, until very recently, held the field in that country, while in the United States this type has been practically superseded by the turbo-blower. Recent information seems to indicate that the latter type is now making headway against the former on the Continent. This is doubtless due to its greater simplicity, lower first and operating cost, and the improved economy in high-pressure steam generation.

It is also probable that with the increased volume and pressure and capacities required for large modern blast-furnaces, which have risen to 60,000 cubic feet, and at some recent plants to 75,000 and 90,000 cubic feet per minute, and up to 30 lb. per square inch, the single unit blower per furnace being preferred, units of such high power are more practical and economical in the turbo-blower type than in the gas engine type.

Power Plant.

In more recent years the feature in new blast-furnace plant installations which has made the greatest advance is the production of power. Considerable economies in this direction have been effected by the use of boiler units of large capacity generating steam at high pressure, 300 lb. per square inch and upwards—in some cases electric generating stations using steam pressures as high as 600 lb. per square inch are in satisfactory operation—with blast-furnace gas burned in automatically controlled burners, and the unit system of powdered coal as alternative standby.

The conversion plant consists of high-pressure, superheated steam turbines for blowers, and for electric generation at high voltage, the latter being transformed to whatever lower voltages are required for each class of power application.

Great attention is paid to the keeping of records in connection with each step in power production operations—for which the standards set for attainment are high—by means of appropriate instruments, for checking results. Boiler steam flow meters, recording pyrometers, draught gauges, steam consumption meters, &c., give complete records of the conditions of power production and of the power consumption of the various using units.

Power-using items adjacent to the boiler plant are usually steam turbine driven and others electrically driven. Boiler efficiencies up to 80 per cent. are stated to have thus been obtained.

Dry Blast.

The economic advantages of dry blast in blast-furnace operation are generally accepted as material, but heretofore the high cost of plant for the extraction of the moisture in the blast has militated against progress in this direction.

The recently introduced method of drying atmospheric air by means of "silica gel," and the installation of such a plant at a Scottish works, has renewed interest in this economic feature. While it is, perhaps, too early to draw definite conclusions as to the efficiency of this device from the results thus far reported which have been very favourable, results over a longer period are awaited with great interest.

Pig Iron Casting.

With modern blast-furnace plant and practice, casting in sand beds for most classes of pig iron is rapidly becoming obsolete; in fact, with large modern outputs that method of dealing with the product is economically impracticable.

When combined with steel smelting, direct transfer of the molten metal in hot metal ladle cars to smelting shop mixers has long been standard practice; but a more recent development in this respect is the growing use of the totally enclosed, or mixer, type of ladle, of comparatively large capacity—originally brought out for special long haulages—for the ordinary transfer of hot metal between blast-furnaces and smelting shop in the same works. This type of ladle is more economical than the usual type of open-top ladle, notwithstanding its higher first cost, owing to its much greater conservation of the heat in the hot metal, the saving in skull formation and in relining repairs. For week-end metal, when not taken by the smelting shop mixers, and for emergencies when metal is not required there, pig casting machines are the usual installation when warranted by the tonnage.

At blast-furnace plants not combined with smelting works, machine casting is becoming standard practice, and this method is now much used, even for foundry iron, though machine sand moulding is making some headway. While there is still some controversy as to whether machine-cast foundry iron is as good as that cast in sand, many foundries are using the former with entire satisfaction.

The Uehling type of pig casting machine, with an endless chain of moulds, with or without a water trough for cooling the iron, is the type now most generally used.

General Lay-out of Plant.

No definite lay-out arrangement can be said to be distinctive of modern blast-furnace plant, as each arrangement of the various sections comprising such a plant is dependent upon local circumstances, the shape of the space available, the ideas of the designing engineer, &c. Where, however, ample space is available, what may be designated as the straight-line lay-out is probably representative of most modern plants. This lay-out is designed primarily for straight-through railway lines in touch with practically every part of the plant from either end, "dead end" branch roads being entirely eliminated or reduced to a minimum. The plant may be said to be divided into "lines" comprising:—

The power production and power conversion section.
The furnace, hot-blast stove, and gas-cleaning section.
The raw material storage bunker and charging equipment section.
The raw material storage ground and bunker charging equipment section.
The raw material receiving equipment section.

Between the sections run one, two or more through railway lines, with crossovers, which serve the various portions of the plant, and, where necessary, short branches from the through roads serve specific points.

When a plant consists of two or more furnaces—multiples of two—each pair may form a two-furnace unit. The hot-blast stoves for each pair are placed between and in line with the two blast-furnaces, or else the furnaces may be placed side by side in the middle, with the stoves in line outside.

All through railways eventually join into two or more main roads beyond each end of the plant, thus providing access to any part of the plant from either end, the main roads being also connected by a road, or roads, running along the outside of the whole plant. In the lay-out of the railways, consideration must be given to suitable locations for weighbridges, so that all incoming and outgoing materials may be accurately weighed without danger of congestion.

Compactness and railway accessibility, without congestion, are the principles aimed at; the former provides for convenience of supervision, and the latter for ease and economy in distribution of raw materials and the disposal of products and waste materials.

Offices, laboratories, shops, &c., are placed in the open spaces between the converging roads beyond the plant proper, as such space permits, or at any other convenient points.

Use of Recording Instruments in connection with the Operation of the Blast-furnace.

In view of the great increase in the outputs of modern blast-furnaces, it becomes imperative that the various operations be very carefully supervised, and that as far as is possible such supervision should be centralised. As it is humanly impossible for one person to keep in contact with all operations at all times, modern works have been equipped with a large number of automatic measuring instruments, mostly of the recording type, and generally assembled in one room. One or more assistants are set to watch the variations shown by the different instruments. The moment anything abnormal is noticed, the man for the time being in charge of the blast-furnaces is notified as soon as possible, so that he can investigate the cause of the disturbance and take steps at once to put it right.

The items generally indicated or recorded in the instrument room are the following:—

(1) Height of stock line in the furnace and number of charges.
(2) Temperature and pressure of gas at top of furnace.
(3) Number of revolutions of blowing engines or volume of blast blown.
(4) Pressure of blast before entering stoves and pressure in the circular main.
(5) Temperature of blast in circular main.
(6) Temperature of blast at stove outlet, as a check for that in the circular main.
(7) Temperature of flue gases at chimney valves of stoves.
(8) CO_2 contents of flue gases at chimney valves of stoves.
(9) Pressure of gas in main.
(10) Volume of gas going to stoves (in group).
(11) Volume of gas going to power-house.

(12) Pressure of gas before entering gas-cleaning plant and pressure when leaving.
(13) Volume of gas stored in holder.
(14) Steam pressure and volume of water evaporated, if blowing and power plants are steam driven.
(15) Bus-bar voltage at generating station.

An attempt is being made in Germany to do all the charging of stoves—*i.e.*, operation of all valves—from the instrument room by either electric or hydraulic power. In a good many plants the gas and air supplies to stoves are regulated automatically, and in at least one works the analysis of the top gases is made automatically, and the different percentages of their constituents are shown on the instrument board.[1]

Such a system naturally requires a great number of reliable instruments. A numerous staff with special knowledge of the instruments in use is detailed to check their accuracy and to repair those which show defects.

Oxygen Enrichment of Blast.

Much thought has been given to this subject in past years, and at least one practical application was made on a commercial scale to a blast-furnace at Liége, in Belgium.

It is stated that very small additions of oxygen were sufficient to overcome the detrimental effects of the atmospheric moisture in the blast; and that enrichment up to 25 per cent. of oxygen made it possible to dispense with hot-blast stoves, and produced a higher grade of iron. No information, however, appears available as to the commercial results of this trial.

A recent investigation into this subject is embodied in a report by a committee formed under the auspices of the United States Bureau of Mines, on the "Use of Oxygen or Oxygenated Air in Metallurgy and Allied Processes."[2]

A symposium on the "Use of Oxygenated Air in Metallurgical Operations" was held at the New York meeting—February, 1924—of the American Institute of Mining and Metallurgical Engineers; abstracts from the papers forming the symposium, including a summary of the report of the Bureau of Mines Committee, have been published by the American Institute of Mining and Metallurgical Engineers.[3]

The following quotation from the "Foreword" of this pamphlet gives the gist of the result of the discussion at the symposium:—

"An extensive discussion followed the presentation of the papers, which dealt with the matter entirely from a theoretical standpoint. The results of only a limited amount of research work were presented. . . . More experimental work on this subject has not been done because metallurgists have not thought that cheap oxygen could be produced, thinking, 'Why waste time experimenting with a reagent that cannot be procurable in commercial quantities?' while the producers of oxygen have said, 'Why waste money on the development of a process to make cheap oxygen unless we know that there will be a market for it when produced?'

"The discussion brought out two facts. First, many metallurgists believe that their operations can be conducted more economically if they can add oxygen to the air used in various smelting operations; secondly, a number of chemists believe that relatively pure oxygen can be produced in metallurgical quantities at very small cost. Negative views were expressed to both propositions, but so overhwelming was the view that if cheap oxygen could be produced many metallurgical operations would benefit, that it was voted to recommend that the Bureau of Mines continue its research work, pending the production of the cheap oxygen hoped for.

"Few experimental data being available, and the attitude of disputants being based largely on theoretical considerations or on reactions and temperatures incapable of positive proof, it has been decided to publish only a summary of the papers and discussions arising from their presentations. It is believed, however, that this will be sufficient to show the lines of reasoning that have been adopted, and be a guide to others who are to make their own calculations or engage in experimental work."

It appears that no definite conclusions were arrived at by the Committee or from the discussions, except that the Bureau of Mines should continue its research work, and that a process for the production of cheap oxygen should be sought.

This subject, therefore, offers two fields for research, the commercial value of each being dependent upon the other; and the degree of progress in these fields is the factor governing further practical application on a commercial scale.

B.E.S.A. SPECIFICATIONS.

DISTRIBUTION BOARDS.

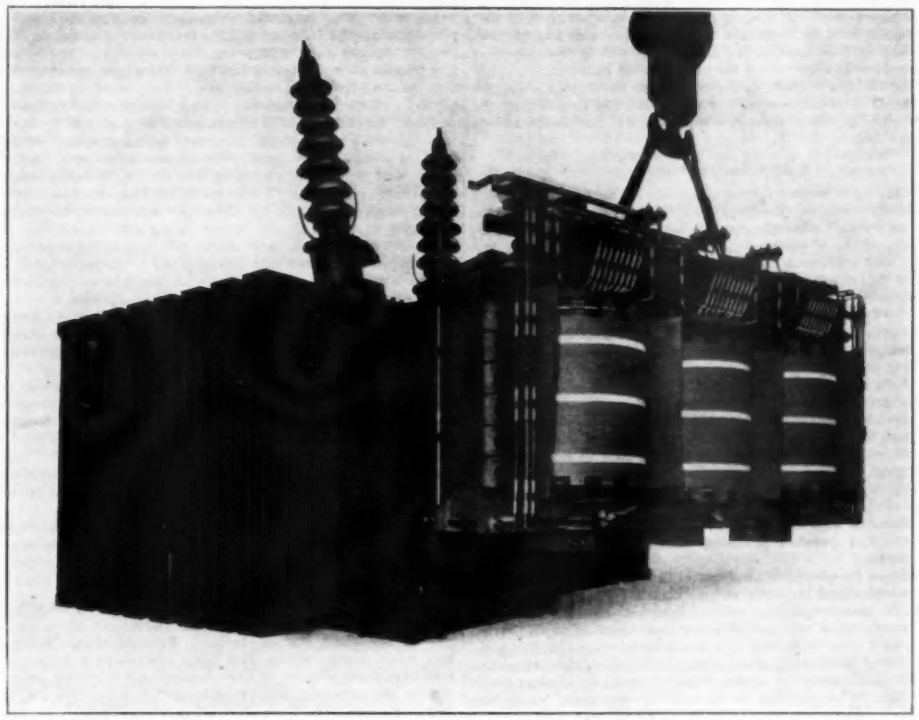
A British Standard Specification for Distribution Boards, which has just been issued, is a further addition to the series of British Standard Specifications for Electrical Accessories and Installation Materials. It relates to two-pole distribution fuse boards and distribution switchboards for ordinary duty with working currents not exceeding 30 ampères per way, and for use in circuits, the voltage of which does not exceed 250 volts. The boards are rated in terms of the largest current per way which can be carried continuously without the temperature rise of any of the parts exceeding a specified amount. There are three standard sizes, namely, 5, 15, and 30 ampères per way. The specification lays down requirements as to design and construction of wood and metal cases, the performance of the switches, if any, and fusible cut-outs, and details of tests to be carried out on completed distribution boards.

Copies of this specification—No. 214, 1929—can be obtained on application to the Publications Department, British Engineering Standards Association, 28, Victoria-street, S.W. 1, price 2s. 2d. post free.

[1] H. Bansen, *Archiv für das Eisenhüttenwesen*, 1927, Vol. 1., October, pages 245–266.
[2] F. Davis, U.S. Bureau of Mines, 1923, "Report of Investigations," No. 2502.
[3] Pamphlet No. 1377–8.

15,000-kVA 132,000-VOLT TRANSFORMER

THE ENGLISH ELECTRIC COMPANY, LTD., LONDON, ENGINEERS



Grid Transformers.

Apart from the primary object of developing the electricity supply industry of this country, the activities of the Central Electricity Board are conferring great benefits upon British electrical manufacturers by giving them the opportunity to develop electrical apparatus for very high voltages and great outputs comparable with the products of foreign manufacturers in point of magnitude. These developments will undoubtedly lead to the setting up of a whole series of records for products of British manufacture. A landmark of this kind is shown in the accompanying illustration, which represents not only the first large 132,000-volt three-phase transformer to be completed for the national schemes, but also the largest unit of the type and voltage which has, at the moment, been produced in this country. The English Electric Company Ltd. has in hand four 15,000-kVA units like that illustrated, four 10,000-kVA units of a similar type, and four 5000-kVA units for 33,000 volts. The following applies particularly to the 132-kV transformers. The high-voltage windings are star connected with the neutral solidly earthed, and advantage has been taken of this to use graded insulation, with considerable resultant economy. The low-voltage windings are connected in delta, and, to provide a neutral, a separate earthing reactor will be installed and used also to give a 440-volt supply for operating auxiliary apparatus. Each transformer is equipped with on-load tap-changing gear to give plus and minus 10 per cent variation in steps of 1·43 per cent. This gear is mounted directly on the side of the transformer tank, and is motor operated with remote control.

The makers' scheme for effecting tap changing under load is one in which the auxiliary auto-transformer, with a middle point, enables the equivalent of twice as many tappings to be obtained as there are actual tappings on the main transformer. The regulating winding is placed towards the neutral end of the high-voltage winding, which, of course, is solidly earthed, but between this winding and the neutral is the reinforced portion of the high-voltage winding, which must necessarily be permanently in circuit.

The 15,000-kVA units are arranged to operate with a mixed system of cooling developed by the English Electric Company. Up to 75 per cent. of full load they will work with natural cooling, the necessary radiating surface being provided by detachable radiators. To dissipate the increased losses at greater loads the cooling effect of the radiators is increased by means of a blast of air directed to the radiator tubes from a motor-driven fan equipment forming part of the layout. This auxiliary cooling equipment is brought into operation automatically by means of a relay controlled by the temperature of the transformer winding. In the case of the 10,000-kVA units natural cooling has been adopted for all outputs.

To facilitate transport of the transformers immersed in oil in their tanks, a valve is fitted to the inlet and outlet connection on the tank for each radiator, so as to permit the radiators to be detached for transport or removed at any time should they become damaged. The transformers themselves are of the five-limb core type, with the windings on the three central limbs, an arrangement which leads to a considerable reduction in the overall height of the core and has the additional advantage that the exciting currents in the three phases are much more evenly balanced than with the usual three-core design. The windings are arranged in a double concentric manner, the low-voltage winding being placed between the two parts of the high-tension winding, the neutral end of which is adjacent to the core. The total weight of each unit is approximately 59½ tons when installed ready for service. The particular units described above are for use in connection with the Central Scotland scheme.

South African Engineering Notes.

Beira Railway Washaways.

Mining and commercial interests in Rhodesia are becoming concerned at the heavy losses and great inconvenience they suffer every few years owing to washaways on the railway from Rhodesia to the Port of Beira. Recent bad periods, when all traffic was stopped, occurred in 1918, 1923, 1926, and now in 1929. The floods this year were accompanied by cyclonic disturbances at Beira and on the coast, causing enormous damage to the port and also damage to ships in the Bay, and sinking small craft. Mr. J. G. MacDonald, speaking at the annual meeting of the Rhodesian Chamber of Mines, of which he is President, stated that it was surely time that, if only in their interest, the railway companies realised that the situation of the Port of Beira, the formation it is built on, the geographical features of the country from there up to Umtali, render all that area susceptible to heavy floods and the port itself to cyclone influences. Beira, he said, would always be a useful port, but it had more than once shaken confidence, and he ventured to suggest to the railways that they might run a risk of literally throwing large sums of money into the sea on the Pungwe seaboard, and would urge on them the necessity of providing a route which would give Rhodesia another outlet to the sea at Delagoa Bay. On the completion of the Limpopo Bridge that would be a simple matter for them to undertake, and perhaps would cost a good deal less in the long run than improvements at Beira, which might conceivably be swept away.

It would appear, however, that the recent flooding of the Pungwe flats and consequent stopping of the railway services occurred while the extensive works, which are being undertaken to prevent the railways being submerged and the embankments washed away, were yet far from completed. The confidence of the engineers that, when these works are completed, there will be no recurrence of the trouble, has been in no way shaken by the recent happening. At the same time there is no doubt that the suggestion to open an alternative route by connecting up the Rhodesian terminus at West Nicholson were the Union Railway, which is to be carried up for a few miles north of the Limpopo, and would give a fairly straight run to Lourenco Marques, is worth careful consideration.

Mines Big Wage Bill.

The South African mining industries and wages bill for 1928 exceeded £20,000,000, and was more than £600,000 higher than that for 1927. Salaries and wages of white employees in 1928 totalled £10,901,518, and coloured workers received an amount aggregating £9,142,066. The Transvaal figures for the gold mining industry were:—Salaries and wages, including allowances, of white employees, £8,449,958, against £8,111,407 for 1927; and coloured workers' wages, £6,939,681, against £6,625,834 for 1927. Last year, white employees received £397,558, as leave pay, and £38,420 as bonus. The total value of stores consumed during the year 1928 was £17,852,931.

Repair Shop and Inspection Sheds at Cape Town.

For the reception of the electric coaching stock for the Cape Town–Simonstown suburban lines, a new repair shop and inspection shed have been built at Salt River, near Cape Town. The inspection shed is sufficiently long to accommodate an eight-coach train, and contains four tracks, the rails of which are carried on reinforced concrete pillars, so that the equipment beneath the coaches is readily accessible. Complete train sets are brought into

this shed for periodical attention to the brakes and equipment generally. Ample siding accommodation is also provided outside the shed for stabling trains.

Transvaal Industry.

Apart from the gold mines, industries in the Transvaal have expanded enormously during the past decade or so. In 1915–16 the industries numbered 1157, but by 1925–26 the total had reached 2344. At the beginning of that decade the value of the output was £14,267,000, while in 1925–26 it was £33,495,000. At that time the employees numbered over 28,000 Europeans and 42,000 natives. The total wage bill was £8,892,000. Later figures would show even more striking industrial expansion in the Transvaal. The last eighteen months has seen the establishment of several new industries, such as pipe-making and wire-drawing, and the manufacture of textiles, cutlery, and gramophones. Engineering, the second industry in the Transvaal, is, of course, centred in the Witwatersrand, and Johannesburg can take particular pride in the expansion of this industry. To-day the Transvaal engineering shops employ about 1800 qualified white workers, 600 apprentices and 1500 natives. They are paid approximately £1,000,000 per annum. The recent Industrial Exhibition at Johannesburg afforded the engineering firms there an opportunity of showing their manufactures, but space prevented exhibits of the bigger side of the industry. Still, there was something illuminating in the pumps and winches, and shaping machines and parts of winding engines and skip wheels and pipes and coal crushers and air and water meters. Such things as railway couplings, quarrying and road-repairing implements, and machinery for irrigation purposes, show the industry's attention to engineering requirements, outside of the mines. It came as a surprise to find the Dunswart Iron and Steel Works, Ltd., exhibiting hollow drill steel, which has been tried and most favourably reported upon. The range of products exhibited covered special steels, including manganese, chrome, vanadium, tungsten, and other alloy steels. The entire output of the company is from Heroult electric furnaces. Rowe, Jewell and Co., Ltd., Old Rand Foundry, exhibited a serviceable and well-designed shaping machine, with a stroke variable from zero up to 25in., and a tool slide travel of 4ft. Wright, Boag and Co. showed a range of winches for underground use at the mines for hauling both trucks and scrapers. One scraper winch was fitted with a 10 H.P. air turbine, and the other, shown in slow motion, driven by a small motor through a 30 : 1 worm reduction gear. E. W. Tarry and Co., Ltd., Austral Ironworks, included in their exhibit an experimental 36in. sluice valve. Altogether, the exhibition must have been a real surprise to many engineers who visited it, including several industrialists from Britain who happened to be over.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Lacking Vitality.

CONSUMPTIVE requirements of iron and steel do not appear to be growing, and though business is steady and regular, there was an evident lack of vitality at the weekly meeting of the Midland iron trade in Birmingham to-day—Thursday. There are matters of policy engaging the attention of both ironmasters and steelmasters, and their thoughts were given to these rather than to sales making. A certain amount of discussion also centred round the forthcoming General Election, endeavours being made to gauge the probable extent of industrial dislocation. Midland manufacturers, most of whom are moderately employed, purchase iron and steel with considerable caution, and no bulk of material is being stocked. It is rare, these days, to hear of forward contracting, orders being almost entirely for supplies for immediate delivery required for current consumption at the works. The regulation of output and the increased costs of iron and steel production are effectively keeping prices up to recent levels. Consumers and merchants press for concessions, and some are of opinion that these will be forthcoming in the near future, but producers are so far unshaken. The keener competition from the Continent and the cutting of prices of steel bars have caused local rollers some anxiety, but they are well placed for orders at the moment, and see no reason to disturb present values. Some easing of prices in this department at a later date would, however, not be surprising. Reawakening of interest in the market is much desired, but hardly expected until the country has settled down after the election. Numerous cases of business being withheld pending the electors' decision are cited.

Steelmasters' Dissatisfaction.

Many steelmasters, including a goodly number in the Midlands, are much displeased—to put it mildly—with the recent decision of the Association to maintain structural material prices at present levels. In view of the increased costs of steel production, they object to the attitude adopted towards prices by the Association, and assert that it is a misuse of the Association's prerogative. The view that it is unwise to interfere just now when business is improving, and an election is being waged is not accepted by dissentient steelmasters, and they are endeavouring to get the matter reopened immediately. Consumers of heavy steel are not to be stampeded by this effort to get prices increased, and on 'Change in Birmingham to-day—Thursday—they showed considerable equanimity. They take the view that although business is undoubtedly better than it has been for some considerable time, there is as yet insufficient incentive to induce them to add materially to their present commitments. It will, they say, be time to act when the matter has progressed further, if, and they doubt it, there is to be any progress on this occasion towards a higher range of values. Constructional engineers, hereabouts find inquiries poor, and consequently they are not buying steel to any extent. Demand for semi-finished material remains brisk, and there is some difficulty in getting delivery. Native billets command £6 10s.—some mills ask £6 12s. 6d.—and Welsh billets are to be obtained at £6 7s. 6d. Continental steel of the same size is quoted £6 6s. delivered into the Black Country. Needless to say, the advantage is insufficient to induce local users to place their orders abroad. British steel bars are firm at £8 15s., and bars re-rolled from imported material are maintained at £8 5s. upwards. There has been a considerable easing of continental steel bar quotations. Bars are now offered at as low as £7 2s. 6d., which is the same figure as applies to No. 3 iron. Steel bars have usually been 3s. or 4s. per ton dearer than iron. With such a wide disparity between native and foreign steel bars, consumers are hesitating before placing new orders at home. Steelmasters hope, however, to continue to hold some of the business they have so recently won from the foreigner in this department of the market.

Iron Prices Stabilisation Scheme.

Midland blast-furnacemen this week gave further consideration to the price stabilisation scheme, certain points of which remained to be settled if it was to be placed on a really durable basis. The scheme has been in operation now for three months, and blast-furnacemen assert that it has been eminently successful. Although one furnace owner has resumed his freedom of action, there has been no break in prices, and supply and demand have been so evenly balanced that there has been no just cause for price cutting. Not all blast-furnacemen are agreed on the restriction of output, while the zone system of delivered prices does not meet with the approval of everyone. Opinions vary on the question of merchants' fixed profit, originally fixed at 9d. per ton. Some furnacemen are conciliatory with regard to the amount, but stress the necessity of leaving no loophole for the weakening of producers' control of selling values. Amongst the merchants there are those who gladly accepted the proffered profit, and much desired its continuance, but others are severe in their criticism of this portion of the scheme. Hand-to-mouth buying of pig iron continues, and supply is, on the average, about equal to the demand. While some furnaces have difficulty in meeting their commitments others are putting small quantities into stock. Prices are firm, Derbyshire No. 3 foundry being £3 12s. 6d. delivered, Northamptonshire £3 9s., and North Staffordshire £3 13s. 6d. The demand for forge sorts has fallen away, but basic maintains a healthy position. Supplies of furnace coke are easier, although values continue in the region of 15s. per ton for Derbyshire and Yorkshire fuel.

Staffordshire Bars.

Staffordshire ironmasters are doing a steady trade in marked bars at £12 per ton, some reinforcement in demand for high-grade iron being traceable to the railway companies. Makers are not yet in a position to see far ahead, but order books are becoming more bulky. In the Crown bar department, orders come in gradually and enable the mills to keep running. Internal competition remains keen, Lancashire and other outside makers competing for a share of this market's business. Values vary from £9 12s. 6d. to over £10, according to make. Nut and bolt and fencing bars sell slowly, the bulk of the material being used in Black Country works having its origin abroad. Staffordshire makers quote £9 and continental makers £7 2s. 6d. delivered. The nut and bolt works are only fairly engaged, and the tonnage of material being absorbed is not large. Wrought iron gas tube strip sells freely at £10 17s. 6d. per ton. There is not the same difficulty in securing deliveries as there was a month or so ago. Local ironmasters re-rolling foreign material are well employed, and are competing with a considerable amount of success against the steelmasters.

Galvanised Sheets.

Galvanised sheets sell at £13 7s. 6d., and a steady trade is being done. Some mills noted for their quality and having still substantial reserves of orders on their books, will not accept fresh orders at below £13 10s. per ton for 24 gauge corrugateds. The export demand for light gauge sheets is poor. The motor engineering firms of the Midlands are consuming good tonnages of black sheets, which are delivered regularly week by week into the works.

Scrap.

Heavy steel scrap is in good demand, and Birmingham merchants are able to dispose of all they can secure at some £4 per ton delivered South Wales. Efforts to bring down selling values have, up to now, met with but little success. Here and there concessions are reported to have been made to old customers, but there has been no general reduction in prices.

Boiler Firm's Record.

A record year both for turnover and profits and an increase of 3000 in the number of hands employed is something to have achieved. This distinction belongs to the associated companies of John Thompson, Ltd., of Wolverhampton, comprising John Thompson (Wolverhampton), Ltd., John Thompson Water Tube Boilers, Ltd., John Thompson Motor Pressings, Ltd., John Thompson (Dudley), Ltd., and Kennicott Water Softener Company, Ltd. At the annual meeting it was reported that operations are being extended in various parts of the world, and works are to be put down in Australia to develop the companies' manufactures.

£125,000 Refuse Disposal Scheme.

Plans have this week been presented to the Birmingham City Council for the reconstruction of the Rotton Park-street depôt for refuse disposal. It is proposed to demolish the existing works, and erect a disposal plant which will be the most up-to-date in the country. The estimated cost is £125,000.

American Plant for Gloucestershire.

R. A. Lister and Co., of Dursley, Gloucestershire, are, according to the statement of Mr. E. Mellerup, a director of the firm, to " copy " the " mechanical efficiency in American foundries " which is reported to be amazing. Having visited some twenty of the chief foundries in the United States, Mr. Mellerup has satisfied himself that they are at least 50 per cent. more efficient than the average British foundry, both in construction and plant, with the result that the tonnage output per man is far in excess of what we get in England. As much of the plant necessary to run a foundry on American lines is stated not to be obtainable in this country, the firm has, much against its wishes, had to place orders for some of its new foundry equipment abroad.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Industrial Outlook.

Rather mixed conditions in the engineering trades locally are reflected by the Manchester Chamber of Commerce in its survey of the general trade situation. The engineering trade, as a whole, it is pointed out, continues to improve, although there are individual exceptions. Lancashire firms were well represented in the British trade delegation to Soviet Russia, and one or two companies which have supplied a good deal of textile machinery in the past have received, or expect to receive, substantial new orders. India, Japan, and several other countries have definitely placed a number of orders for textile machinery, and loom makers especially have been well employed. Orders from the Lancashire textile trades have, however, been scarce owing to the continual depression. The heavy electrical industry has been kept busy, constructional engineers have received a number of big public contracts, and private locomotive builders have had a fair amount of work from foreign railways on hand. The London, Midland and Scottish Railway Company, however, put its great locomotive repairing depôts at Crewe and Horwich on short-time. Machine tools have been in good demand, but some producers have not shared fully in the business done.

From Manchester by Air.

The directors of Northern Air Lines, Manchester, are in communication with the Chambers of Commerce of Liverpool, Hull, Glasgow, and Belfast with the object of finding out what response there will be to the proposal to establish daily air services between Belfast, Liverpool, Manchester, and Hull, and between Glasgow, Manchester, and London. Triple-engined Fokker machines would be employed to carry loads of just over a ton. Northern Air Lines are seeking information as to the availability of a suitable landing-ground and accommodation for one or two large air liners.

Compensation for an Apprentice Fitter.

In the Salford County Court on Tuesday of this week, an apprentice fitter employed by Joseph Berry, Ltd., Albion Foundry, Swinton, was awarded compensation at the rate of 3s. 3d. a week for the loss of an eye. The accident occurred in June of last year, when the youth was holding a chisel for a workman to strike with a hammer in order to remove a rivet. A piece of the rivet or a piece of metal from the hammer flew off, striking him in the eye, which later had to be removed. The firm had paid compensation until January 15th at the rate of 10s. a week. It had offered him his old job again and expressed its willingness to give him all possible consideration to help him to overcome his disability.

Obituary.

The death occurred last Saturday at Lytham, at the age of sixty-five years, of Mr. J. H. Smethurst, who retired quite recently after fifty years' service from the position of waterworks engineer for Preston.

Non-ferrous Metals.

So far as price movements are concerned the course of events on the non-ferrous metals markets since last week has been relatively uneventful. Copper, it is true, has risen to the highest level touched for about a month, but even so it represents an advance of less than £2 a ton compared with the prices current a week ago. This section of the markets has attracted a fair amount of attention, and transactions in the metal have been on an important scale, although, as before, much of the business has been speculative in character. At the moment of writing values are dearer, as stated above, to the extent of slightly below £2 a ton. In the case of tin consumers continue to operate cautiously. For this metal market conditions have been steadier during the week than they have been for some considerable time. So far there has been no indication of a return to above the £200 mark. On the contrary, there has been a further slight loss though this time it can be measured in shillings. Spelter prices have given way to the extent of about 5s. a ton, but there had been a fair demand about during the week. With regard to lead, this continues to meet with a moderate inquiry ; English has been well held, but foreign metal has suffered a very slight loss on balance.

Iron and Steel.

Although there is still comparatively little in the way of renewed forward buying on a general scale, good deliveries of foundry pig iron to users in this part of the country are being made, and sellers have little cause to complain of current conditions compared with those ruling a year ago. Quotations keep firm at 71s. per ton for Derbyshire No. 3, delivered locally, 81s. 6d. for Cleveland ; 90s. for Scotch ; and about 87s. for West Coast hematite. Only a quiet trade is reported in finished iron, but Lancashire Association prices are held at £10 10s. per ton for Crown, and 10s. less for seconds. In spite of the fact that some of the rolling mills have reported better sales of constructional steel to Lancashire firms, the specifications have

been strictly for early delivery, and there has been no fundamental improvement in the situation. The demand for ship plates is rather subdued, but for locomotive plates several decent orders have been booked locally. Values are still firm all round, with joists at £7 17s. 6d.; ship plates at £8 12s. 6d.; acid boiler-plates at £9 17s. 6d.; and basic sorts at £9 12s. 6d.; large bars at £8 17s. 6d.; and small rerolled varieties at about £8 10s. There has been a slight shading during the past week of imported steel bars, but otherwise the foreign section is unchanged with regard to prices, and not much weight of business is being placed in this part of the country with continental mills.

BARROW-IN-FURNESS.

Hematite.

The satisfactory tone reported last week continues in the West Coast hematite pig iron trade, and makers are better circumstanced than they have been for a considerable time. Buyers are more inclined to place orders for forward delivery owing to the realisation that the present prices are firm and likely to be. It is just possible that if there was any alteration in prices it might be regretted by some that they had not placed orders before. Special qualities are finding a good market and orders are well booked forward. The deliveries to America have not quite finished, and there are prospects of further business. There have been shipments coastwise to ports in South Wales, and these are becoming more regular. The iron ore trade is slightly better, for apart from a better demand locally there is a better trade outside the district. Foreign ore is arriving in a steady tonnage. The steel trade continues to be fair, but the competition is still keen. The rail and merchant mills are engaged at Barrow, and the hoop works are fully employed.

SHEFFIELD.

(From our own Correspondent.)

An Improved Tone.

THE condition of the various branches of the steel trade in this locality does not show much change from last week, but such movement as is noticeable is in the right direction, and there is a better tone in industry. The basic side of the heavy steel trade is still actively employed, and is contributing its share towards the general increase in steel production, as compared with pre-war years, which the country is displaying. The same cannot be said of the acid steel department, of wagon building, or of the railway steel branches, which are as depressed as ever. The rolling mills report increased bookings of work at the beginning of this month. There has been a falling off in the buying of colliery equipment, stores, and tools, but demand continues good for motor supplies, special forgings and castings, cold-worked steel, magnet steel and stainless steels. Huge quantities of small magnets are now made in the city to supply the demands of the wireless industry.

A Scrap Difficulty.

A serious problem confronting the steel industry is the scarcity of heavy steel scrap and its dearness. During the past year, the price of this material has gone up by nearly £1 per ton. As the use of scrap in the steel furnace has increased greatly in recent years, and now amounts to 50 or more per cent. of the charges, the position is one of real difficulty. It is due, in considerable measure, to the heavy shipments of scrap to the Continent, where it is admitted duty free. Many British steel makers are of opinion that this exportation ought to be regulated by the Government, if not prohibited, and, in a memorandum issued by the National Federation of Iron and Steel Manufacturers, it is contended that it is contrary to the interests of this country to permit the unrestricted export of what is, in fact, an essential raw material of one of our basic industries. It is argued that the dearness and scarcity of this material is retarding the improvement of the British steel industry. Between 1913 and 1928 exports of scrap rose from 117,000 tons to 345,000 tons, and in the first quarter of this year they were at the rate of 468,000 tons per annum. According to the latest market reports, supplies are at the moment more ample, but the enhanced prices are being maintained.

New Blast-furnace.

The Renishaw Iron Company, Ltd., Derbyshire, has brought into operation a recently erected blast-furnace at its works. It has a capacity of nearly 1200 tons of pig iron per week. There are now two furnaces running at these works.

An Order for Wagons.

The Metropolitan Cammell Carriage and Wagon Company, which was recently formed by an amalgamation of certain interests of the Sheffield firms of Vickers and Cammells, has received another large order for all-steel wagons. The company is to construct eighty vehicles of 90-ton capacity, specially designed for the carriage of iron ore, for the Bengal-Nagpur Railway Company. The order also includes twenty bogie rail wagons, each of 64 tons. It will be executed at the Washwood Heath Works, Birmingham.

Sheffield and the Schneider Trophy.

The forthcoming seaplane race for the Schneider Trophy, on the Solent, is of much interest to Sheffield, as its steel firms are putting forth their best efforts to produce material of the highest efficiency for use in the engines of the craft that will be employed. Sheffield has been largely concerned in the production of material used in previous Schneider contests, as well as in Major Segrave's and other record achievements. In racing seaplane engines the steels used for the vital parts are subjected to exceedingly heavy stresses, and to meet the demands made upon the materials the testing and analysis of the special steels now being produced are being performed with extraordinary care.

A Huge Silk Factory.

Further definite steps have been taken in connection with the building, near Selby, of what will be the largest artificial silk mills in the North of England. The Dutch firm of Breda Visada, Ltd., has acquired the Barlow airship station, covering several hundred acres, and is to start work on the alterations and new construction this summer. The firm's registered English office is at Littleborough, near Manchester. The equipment of the site already comprises a machine shop and a fabric shed, with several hundred thousand feet of floor space. It has its own railway station and two lines of private rails connecting up at Barlow with the main L.N.E.R. line from Selby to York. It is stated that the scheme will cost £4,000,000 to complete, and that the mills, when in operation, will employ 4000 hands, for whom a garden city is to be constructed. The mills are expected to be in operation by the summer of next year.

Opening Up the East Coast.

The question of providing improved facilities for linking up the two sides of the river Humber has been under discussion for a considerable time, and is now to be brought prominently forward. The great districts of which Hull is the centre on the Yorkshire side and Grimsby on the Lincolnshire, are feeling in an increasing measure the need of better communication than the present ferry service, and Hull City Council has decided to convene a conference of all municipal, urban and county bodies, as well as others concerned, to go into the question of promoting a scheme for bridging or tunnelling the Humber in order to provide adequate rail and road transportation facilities. "A bridge or tunnel," said the sponsor for the motion, "will open up the East Coast in a way that we have never known before." Some years ago Mr. T. R. Ferens, of Hull, collected information on the subject of tunnelling the river. The cost at that time was estimated at £3,000,000, but that sum would no doubt prove inadequate at to-day's enhanced prices.

Ex-Master Cutler Dead.

The death occurred on Sunday of Mr. Herbert Barber, who was Master Cutler of Sheffield in 1909–10. For upwards of forty years he had been partner in the old-established firm of Daniel Doncaster and Sons, now amalgamated with the United Steel Companies, and he was a director of the latter and of several other local concerns. He was seventy years of age.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

TRADE development continues along sound, steady lines, and the market is gathering strength as the result of the growing inclination of customers to cover forward requirements. The already good home demand promises to expand, and inquiries from abroad encourage hope of further improvement in the export trade. It must be almost without precedent in the history of the Cleveland iron trade that ironmasters should be unable to accept orders for pig iron even for delivery three months ahead. Such, however, is the position now. Outputs have been substantially increased, and possibly might be still further added to if ore supplies were more abundant. The shortage of iron is, however, really occasioned by the enormous demand for basic iron for the steel works. To meet this need is the first care of the ironmasters, and the surplus iron for the open market is not sufficient for industrial needs. Thus buyers have deemed it prudent to buy well ahead, and a stage has been reached when ironmasters cannot undertake further commitments, and are refusing orders. In some cases, in fact, full deliveries against running contracts are not forthcoming. A mishap at the Jarrow works of Palmer's Shipbuilding and Iron Company, Ltd., has delayed the re-kindling of two blast-furnaces there, but the number of furnaces in blast on the North-East Coast will shortly be increased to forty-two, and as the capacity make per furnace has been much enlarged, output is not much below that of pre-war normal days, when approaching seventy furnaces were in operation. For August–September delivery No. 1 grade of Cleveland iron is 71s.; No. 3 G.M.B., 68s. 6d.; No. 4 foundry, 67s. 6d., and No. 4 forge, 67s.

Iron and Steel Imports.

Iron and steel imports into the Tees during April were over 7000tons lower than in the corresponding month a year ago, but they are still 10,000 tons above the pre-war monthly average. Statistics presented at this week's meeting of the Tees Conservancy Commission embraced the imports for six months. Crude sheet bars, billets, blooms, and slabs unloaded in the port in April totalled 8224 tons. The total for the six months was 50,347 tons. A year ago for the same period the imports came to 88,107 tons, and the 1913–14 total was 24,134 tons. Pig iron, the importation of which was virtually unknown in pre-war days, reached the Tees from other countries during April to the extent of 599 tons, which was a big drop on recent averages. In the early part of the year the average was 4000 tons. The total for the last six months is 17,919 tons, as against 4106 tons in the corresponding period a year ago and 106 tons only in the 1913–14 period. The importation of plates, bars, angles, rails and sheets reached 7957 tons in April, and the figure for the last six months is 23,987 tons. The comparative figure a year back was 20,725 tons, and in 1914 it was 13,460 tons. The total quantity of iron and steel imported during the past six months was 92,253 tons, as compared with 112,938 tons a year ago and 37,700 tons over the corresponding 1913–14 period.

Hematite Pig Iron.

There is next to no East Coast hematite pig iron to be had before late June. Makers are well sold for the next month or two, and are in no hurry to commit themselves further ahead. Merchants are moderately well bought, but they look for an advance in price and are not pressing sales. Prices are still comparatively low in comparison with Cleveland pig iron, ordinary hematite being obtainable at 5s. 6d. above the price of No. 3 Cleveland, whereas the difference used to be 8s. to 10s. For late June delivery and onward hematite commands 74s. and upwards according to quality.

Ironmaking Materials.

No material change is noticeable in the foreign ore trade. Merchants have good contracts arranged and are unperturbed by the continued absence of consumers from the market. Quotations keep firm at the equivalent of best Rubio at 23s. c.i.f. Tees. Coke seems unlikely to become at all plentiful and values are upheld. Exporters have returned to the market, and a few good overseas sales have been made. Good average blast-furnace qualities continue to make round about 19s. delivered at the works in this area.

Manufactured Iron and Steel.

Active conditions prevail in the manufactured iron and steel trade. A considerable amount of business is steadily coming forward in all branches of the industry, and most firms are sold well ahead. Continued brisk demand for semi-finished steel keeps plant running at high pressure, and prices are very firm. Most descriptions of finished steel are selling well to home customers, and indications of early expansion of export demand are not absent. Finished steel prices are firm, but unchanged.

The Coal Trade.

The prolonged cold weather has been very beneficial to the Northern coal trade. Every country in Europe is more or less consuming coal for warmth at the winter level, and the cumulative effect of this is shown by the demand which, for this time of the year, is unusually heavy. There are very large shipments of steam and house coals for home destinations, and it is said that in Germany and other continental countries gas coal stocks have not been fully replenished since the February frost. Consumers abroad of both steam and gas coals are likely to maintain greater reserves of fuel in coming winters, after their experience in the early part of this year, and that provision is now about to be made. These are factors which keep up prices, and create favourable conditions for the industry. May trade for prompt coal has come along in fair volume, and there is every sign that the first half of the year will show very heavy shipments. Best Northumberland steams are firmly held at 14s. 6d. to 15s., and seconds at 13s. 6d. to 13s. 9d. Pits are shipping or otherwise disposing of their full output, and bookings ahead are on a large scale. Small steams are being well taken up at 9s. 6d. to 10s. For Durham steams the recent strong position is maintained, and neither large nor smalls are obtainable except in small odd parcels at 18s. 6d. and 12s. 6d. respectively for large and smalls. Durham gas coals continue to meet with an active inquiry. Best qualities are scarce at about 15s. 6d., and secondary kinds are quoted steadier at 15s. Durham coking unscreened are in keen demand, and scarce for weeks ahead, with the result that 15s. to 16s. is the minimum indicated price. Unscreened bunkers are holding steadily to 15s. 3d. to 15s. 9d. Inquiries for coke are numerous, but merchants are not keen to accept business at present prices. Supplies of gas coke are offered at steady prices of 18s. 6d. to 19s. Patent oven cokes are in good supply, but continental buyers are not pressing, and the tendency is easier at 17s. 6d. to 18s. Special foundry coke is plentiful at 24s. to 26s., and beehive coke firm at 28s.

SCOTLAND.

(From our own Correspondent.)

Quiet Outlook.

IN the steel, iron and coal markets business is quiet generally. The course of trade is slow, and without direct indication of any change for the better. In many instances costs of production have increased, and the prices now realised leave little, if any, margin of profit.

Steel.

Conditions in the steel trade are more or less unchanged. So far as heavy steel is concerned, sections continue in better demand than plates. Specifications for the latter are far below expectations, and, as a matter of fact, one large establishment at least is at a standstill, owing to the scarcity of orders.

Steel Sheets.

Business in steel sheets is disappointing for the season of the year, the demand being dull, more especially in the heavy department. Competition from abroad is very keen, and it is said that the prices obtained are too low in relation to the increased cost of imported sheet bars and slabs. Prices are unchanged, but have a stronger tendency.

Tubes.

Tube makers are busy in practically all branches, and inquiries are still fairly generous.

Iron.

Bar iron remains inactive, with prices still unchanged, despite the increased quotations in other districts. Re-rolled steel bars, though comparatively busy in certain

lines, are not now particularly well placed. They are quoted £8 home and £7 15s. per ton export.

Pig Iron.

There are now twenty-five pig iron furnaces in blast in Scotland. Business has been a shade brisker of late, especially in hematite. Quotations remain at the minimum levels recently fixed, but makers consider that the prices obtained are barely remunerative.

Exports and Imports.

Over 17,000 tons of iron ore and 2000 tons of iron and steel, also 600 tons of pig iron, were unloaded at Glasgow Harbour during the past week. Exports included 5700 tons of steel and iron and 1136 tons of pig iron.

Coal.

The position in the coal trade has not improved. The collieries generally report poor demands for round coal, and sidings are becoming congested with wagons loaded with unsold fuel. Home demands continue to decline and shipping orders are irregular, and of small dimensions. Treble and double nuts have had a better outlet lately, and have firmed a little in price, but all other fuels are weaker. Foreigners still decline to buy forward, and any prompt business concluded is, as a rule, of small account. As was anticipated, the Swedish State Railways have declined the recent offers to supply locomotive coal over the season, and now have issued tenders for 300,000 tons locomotive fuel, 18,000 tons bunker coal, and 10,000 tons of coke. It is also stated that offers of locomotive fuel have been wired to the Latvian State Railway Authorities, whose requirements amount to about 80,000 tons for May–December delivery. Aggregate shipments during the past week amounted to 284,785 tons, against 228,024 tons in the preceding week and 245,642 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the steam coal section this week is not so satisfactory, and values have gradually been slipping back. Values are, in fact, somewhat indefinite and extremely irregular for the reason that the situation of individual undertakings is so varied. At the end of last week there were twenty-six idle tipping appliances at the various docks, and only three steamers were waiting to berth, while arrivals of tonnage over the week-end were very disappointing. The result was that on Monday, instead of the dock position being better, it was worse, as there were twenty-nine idle tipping appliances and only six vessels were waiting to berth. It has been felt for some time past that the question of tonnage would be a dominating one during this month, and unfortunately expectations of a shortage of supply have been realised. It is safe to say that the weakness in the coal conditions at the present time is due more to the inadequacy of prompt tonnage than to a paucity of orders. There are many complaints that the inquiry for coals is on the slow side, and that foreign buyers are holding off; but the fact remains that numerous orders are already held and shippers have not been able to execute them owing to their inability to secure the tonnage they require. It is, of course, easy to say that tonnage can be obtained if a high enough rate of freight is paid, but of late merchants have experienced great difficulty in getting the right boats, even though they have been prepared to pay what may be considered very reasonable rates. Proof that there is a shortage of tonnage is forthcoming in the advance which outward rates have displayed during the past week or so, values having risen fully 1s. per ton for quite a number of destinations. So far as collieries are concerned, it may be true that business is not as brisk as could be desired, but if tonnage was put at their disposal to lift the coals which they have got sold on their books, their position would be considerably better and prices would be far steadier than they actually are.

Shipments and Coal Contracts.

Considering the general complaints of the shortage of new orders and of tonnage, it is rather surprising to find that the returns of coal exports from this district last week were so good. The position would appear to be extremely conflicting. The total is given as over 623,000 tons, which compares with 478,538 tons for the preceding week and with 350,000 tons for the week ended May 4th of last year. The fact is that the total for last week has been swollen by belated returns made to the Customs, and which in all probability should have been included in the previous week's figures. To some extent the returns are therefore misleading. It is to be feared that the total for the current week will not be anything like so good. So far as can be ascertained, there has not been much done in the way of coal contracts, except that the Norte Railways of Spain have purchased about 20,000 tons of Welsh coals for delivery over June and July. This business has been taken by two Cardiff firms. There is no news yet regarding the Central Railways of Brazil having bought the 200,000 tons of Wesh coals of superior quality for which they were inquiring a fortnight ago.

Tin-plate Trade.

Very steady conditions prevail in the tin-plate trade and prices are reported to be firm. In regard to the question of a new tin-plate sliding scale, it is stated that negotiations are proceeding satisfactorily, an important meeting having recently been held in London. It is understood that a further meeting is to be held in a fortnight's time. In the meantime, the Transport and General Workers' Union has been notified by the Executive of the Employers' Association that the *ex-gratia* bonus of 2½ per cent. and 7½ per cent.—the latter for the lower-paid workmen in the tin-plate trade—will be continued for another period to August 3rd, upon the same conditions as those now in operation, providing that in the meantime no claims are made of a general description. The arrangement is also conditional, of course, to any agreement that may be come to in the meantime regarding the establishment of a new sliding scale.

Liners at Cardiff.

The Canadian Pacific Railway Company has decided to berth the liner "Minnedosa" at Cardiff on the 25th inst. This is a vessel of 15,200 tons, and is slightly smaller than the liner "Montrose" which made her second call at Cardiff on Saturday last and took 650 emigrants for Montreal and Quebec. When the "Montrose" was previously at Cardiff on April 6th, about 350 emigrants embarked.

Miners' Holidays.

It has been decided that the workmen in the coalfield be granted three days' holiday at Whitsuntide, viz., Whit Monday, Tuesday and Wednesday, the night men to return to work on the Wednesday night.

Current Business.

The tone of the steam coal market continues to be quiet, and prices are extremely uneven for early loading. Owing to the insufficiency of ready tonnage stocks are accumulating, and making it difficult for some collieries to work regularly. There was no work at all at most collieries on Monday last, which was May Day, and was devoted to demonstrations by the workmen. Doubtless, the position of some undertakings would be even less satisfactory but for this interruption of production. Prices of superior Admiralty large coals are round about 20s. 6d. to 20s. 9d., while best smalls are 13s. 6d. to 14s. Pitwood has fallen away, and is about 25s. 6d. to 25s. 9d.

LAUNCHES AND TRIAL TRIPS.

FAIRLAKE, single-deck screw steamer; built by Barclay, Curle and Co., Ltd., to the order of Fairport Steamship Company, Ltd.; dimensions, 259ft. by 43ft. 2in. by 20ft.; to carry 2585 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, April 22nd.

BARON VERNON, steel screw cargo vessel; built by D. and W. Henderson and Co., Ltd., to the order of H. Hogarth and Sons, Ltd., Glasgow; dimensions, 350ft. by 50ft. by 25ft. 9in. Engines, triple-expansion, 21½in., 37in., 62in. by 42in. stroke, pressure 210 lb. per square inch; constructed by the builders; launch, April 23rd.

LADY MEATH, twin-screw cattle and cargo boat; built by Ardrossan Dockyard, Ltd., to the order of British and Irish Steam Packet Company, Ltd.; dimensions, 320ft. by 40ft. by 25ft. 2in.; to carry cattle and cargo. Engines, triple-expansion, 16in., 27in., 44in. by 33in. stroke, pressure 200 lb. per square inch; constructed by J. C. Kincaid and Co., Ltd., Greenock; trial trip, April 23rd.

MELROSE ABBEY, single-screw steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of the Hull and Netherlands Steamship Company, Ltd.; dimensions, 280ft. by 38ft. by 18ft. 3in.; to carry passengers and cargo. Engines, triple-expansion, 21½in., 37in. and 64in. by 42in. stroke, pressure 220 lb. per square inch; constructed by the builders; trial trip, April 23rd.

SIOUX, single-screw steamer; built by Barclay, Curle and Co., Ltd., to the order of St. Lawrence Steamships, Ltd., Welland, Ontario, Canada; dimensions, 259ft. by 43ft. 4in. by 20ft. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 23rd.

TAMARE, shallow-draught oil tanker; built by Harland and Wolff, Ltd., to the order of Lago Shipping Company, Ltd.; dimensions, 335ft. by 55ft.; to carry petroleum in bulk. Engines, twin-screw triple-expansion, pressure 180 lb. per square inch; constructed by the builders; launch, April 23rd.

AGAMEMNON, passenger and cargo vessel; built by Workman, Clark (1928), Ltd., to the order of Messrs. Alfred Holt and Co., Liverpool; dimensions, 475ft. by 59ft. by 35ft. 3in. Engines, two sets eight-cylinder Burmeister and Wain four-stroke Diesel engines; launch, April 25th.

PEVERIL, single-screw cargo vessel; built by Cammell Laird and Co., Ltd., to the order of the Isle of Man Steam Packet Company, Douglas, I. of M.; dimensions, 205ft. by 34ft. 6in. by 16ft.; to carry cargo. Engines, triple-expansion, pressure 200 lb. per square inch; constructed by the builders; launch, April 25th.

ULSTER PRINCE, motor vessel; built by Harland and Wolff Ltd., to the order of the Ulster Imperial Line (Belfast Steamship Company, Ltd.); dimensions, 345ft. by 46ft. by 19ft.; to carry passengers. Engines, two ten-cylinder airless injection trunk type Diesel engines of the Harland-B. and W. type; constructed by the builders; launch, April 25th.

WESTRALIA, twin-screw motor passenger vessel; built by Harland and Wolff, Ltd., to the order of Huddart Parker, Ltd.; dimensions, 430ft. by 60ft. by 33ft. 6in.; to carry 360 first-class and 90 third-class passengers. Engines, two sets Harland-B. and W. single-acting eight-cylinder Diesel engines; constructed by the builders; launch, April 25th.

PORTWELL, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Welland Steamship Company, Ltd., Welland, Ontario, Canada; dimensions, 260ft. by 42ft. 4in. by 20ft.; to carry 2600 tons deadweight. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 26th.

HIGHLAND BRIGADE, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of H. and W. Nelson, Ltd.; dimensions, 520ft. by 69ft. by 35ft. 9in.; to carry passengers and cargo. Engines, two eight-cylinder double-acting four-cycle motor engines of the Harland-B. and W. type; constructed by the builders; trial trip, April 27th.

MAYA, steamship; built by Barclay, Curle and Co., Ltd., to the order of the Cuyamel Fruit Company, New Orleans, U.S.A.; dimensions, 405ft. by 53ft. 2in. by 33ft. 6in.; to carry cargo and passengers. Engines, triple-expansion, 30½in., 51in., 62in., 62in. by 48in. stroke, pressure 200 lb. per square inch; constructed by the builders; trial trip, April 27th.

STARWELL, steamship; built by Swan, Hunter and Wigham Richardson, to the order of Welland Steamship Company, Ltd., Welland, Ontario, Canada; dimensions, 260ft. by 42ft. 4in. by 20ft.; to carry about 2600 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, April 29th.

HERONSPOOL, cargo steamer; built by Wm. Gray and Co., Ltd., to the order of Pool Shipping Company, Ltd., West Hartlepool; dimensions, 434ft. 4in. by 54ft. 3in. by 30ft. 1in.; to carry cargo. Engines, triple-expansion, 26½in., 44in., 73in. by 48in. stroke, pressure 180 lb. per square inch; constructed by Central Marine Engine Works of the builders; trial trip, April 30th.

LOCKWELL, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Welland Steamship Company, Ltd., Welland, Ontario, Canada; dimensions, 260ft., 42ft. 4in. by 20ft.; to carry about 2600 tons. Engines, triple-expansion, pressure 180 lb. per square inch; constructed by the builders; trial trip, May 2nd.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE President of the French Republic has, on the recommendation of the Association Technique Maritime et Aeronautique, conferred the Legion of Honour upon Mr. Robert W. Dana, Secretary of the Institution of Naval Architects.

MR. WALTER T. DUNN, M.I. Mech. E., F.C.I.S., formerly secretary to the Institution of Gas Engineers, asks us to announce that he has removed from 4, Wavertree-road, Streatham Hill, London, and is now living at 72, Elphinstone-road, Hastings.

THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS asks us to announce that its offices have been removed from 92, Victoria-street, Westminster, to 84, Eccleston-square, London, S.W. 1, and requests that in future all communications should be sent to the latter address. The telephone number remains the same, *i.e.*, Victoria 5083.

MESSRS. MARSHALL, SONS AND CO., Ltd., engineers, Gainsborough, ask us to announce that Mr. Ivan W. Benson, late of Bush House, Aldwych, W.C. 2, no longer represents their interests in "Cummer" asphalt plants and concrete mixers, and ask that all inquiries for those sections of the firm's manufactures should be addressed to Gainsborough.

THE GENERAL ELECTRIC COMPANY, Ltd., asks us to announce that its Ipswich Branch is being moved, as from Monday, May 13th, from Commercial Union-buildings, Princes-street, to larger premises in Westgate Chambers, 40s, Westgate-street, Ipswich. The telephone number and telegraphic address will remain as at present, viz.:—Ipswich 2379, and "Electricity," Ipswich.

SIR JAMES ALFRED EWING, K.C.B., LL.D., D.Sc., F.R.S., M. Inst. C.E., has, under the Order in Council dated February 6th, 1928, been appointed by the Lord President of the Council to be a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, to fill a vacancy occasioned by the death of Mr. Robert Whyte Reid, C.B.E., M.I.M.E.

CONTRACTS.

BOLCKOW, VAUGHAN AND CO., Ltd., of Middlesbrough, have received an order for 9000 tons of rails and fish-plates for the Argentine.

THE RUBEROID COMPANY, Ltd., of Lincoln House, 296–302, High Holborn, London, W.C. 2, carried out the roofing of the principal buildings at the North East Coast Exhibition.

THE DARWIN STEEL COMPANY, Ltd., of Sheffield, has received from the International Company of Philips, the wireless receivers of which are made and sold in this country by Philips Lamps, Ltd., London, an order to the value of £100,000 for Darwin magnet steel.

CAMBRIDGE INSTRUMENT COMPANY, Ltd., has just received an order from the Gas Light and Coke Company, Ltd., London, for fifteen Thomas recording gas calorimeters, eight of which are to be equipped with duplicate recorders, making a total of twenty-three recorders in all.

SIR W. G. ARMSTRONG, WHITWORTH AND CO., Ltd., have received from the High Commissioner for India an order for the construction of eleven 4–6–2 locomotives and tenders for the Eastern Bengal Railway. These engines are to be of the new standard type adopted by the Indian Railway Board for the broad gauge 5ft. 6in. lines. The same firm has also secured an order from the High Commissioner for India for the construction of twelve 4–6–2 locomotives and tenders of the new standard X.B. type for the 5ft. 6in. broad-gauge lines of the Madras and Southern Mahratta Railway.

EDWARD BENNIS AND CO., Ltd., have recently received orders for (*a*) mechanical chain-grate stoker equipments for water-tube boilers for the Harrogate Corporation electricity works; the India Rubber, Gutta Percha and Telegraph Works Company, Ltd., and for the Brentford gasworks of the Gas Light and Coke Company; (*b*) mechanical stoking equipment for Lancashire boilers from Herbert Green and Co., Ltd., Hull; the Pontefract Collieries, Ltd.; A. R. Brown, McFarlane and Co., Ltd., Glasgow, for Japan; and for Wallpaper Manufacturers, Ltd.; (*c*) mechanical coal and ash-handling plants for Wallpaper Manufacturers, Ltd.; Ashmore, Benson, Pease and Co., Ltd.; the Grimsby Corporation electricity works; the Birtley Iron Company, Ltd., Birtley, Co. Durham; the Douglas Corporation electricity works; and the Distillers Company, Ltd., Liverpool.

CATALOGUES.

ATELIERS DE CONSTRUCTIONS ELECTRIQUES DE CHARLEROI, 56, Victoria-street, S.W. 1.—"Centrifugal Pump Catalogue No. 1002 E."

B.E.N. PATENTS, Ltd., 92, Tottenham Court-road, W. 1.—A catalogue dealing with the "B.E.N." spray gun for low-pressure spray painting.

FLEMING SAFETY GOGGLES, 146, Clerkenwell-road, E.C. 1.—Price list 224 of safety goggles, helmets, and respirators for protection in industry.

ENGINEERING GOLFING SOCIETY.—The spring meeting of the Engineering Golfing Society will be held at Deal on Saturday and Sunday, June 8th and 9th, by the courtesy of the Royal Cinque Ports Golf Club. The following programme has been arranged:—On the Saturday morning the "Timmis Challenge Cups," presented by Mr. E. W. Timmis, will be competed for by four-ball foursome match play against bogey in an eighteen-hole round. Mementoes and second prizes will be given. In the afternoon there will be an eighteen-hole round two-ball foursome match play against bogey. Two first and two second prizes will be given. On the Sunday morning the "President's Challenge Cup," presented by Sir Alexander Kennedy, will be competed for by members in the First Division, with handicaps of 10 and under, and the "Wilson Challenge Cup," presented by Mr. Reginald P. Wilson, by members in the Second Division, with handicaps of 11 and over, in an eighteen-holes stroke round under handicap. A memento and a second prize will be given in each division. There will also be prizes for the best scratch scores in each division, presented by the Captain. The Northern Meeting of the Society will be held at Gullane on No. 1 Course on Whit Monday, May 20th, when the "North" Cup will be played for.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 21/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 18 0	—
No. 1 Foundry	3 15 0	—
No. 3 Foundry	3 12 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 14 0	3 14 0
No. 1	3 14 6	3 14 6
Cleveland—		
No. 1	3 11 0	3 11 0
Silicious Iron	3 11 0	3 11 0
No. 3 G.M.B.	3 8 6	3 8 6
No. 4 Foundry	3 7 6	3 7 6
No. 4 Forge	3 7 0	3 7 0
Mottled	3 6 6	3 6 6
White	3 6 6	3 6 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 11 0	—
" " Foundry	3 13 6	—
(3) Northampton—		
Foundry No. 3	3 9 0	—
Forge	3 5 0	—
(1) Derbyshire—		
No. 3 Foundry	3 7 6	—
Forge	3 3 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 12 6	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 4 6 (a) / 4 7 6 (b) / 4 11 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 10 0	—
Second Quality Bars	10 0 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 15 0 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 17 6 to 9 2 6	—
Gas Tube Strip	10 17 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0	13 12 6 to 13 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
" (Small Round)	8 10 0	—
Hoops (Baling)	10 0 0	9 15 0
" (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
" (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 10 0	—
Soft Wire Rods	7 12 6	—
MIDLANDS—		
Small Rolled Bars	8 5 0 to 8 15 0	—
Billets and Sheet Bars	6 7 6 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 7 6 to 13 10 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/4½ to 18/9
Block Tin (cash)	197 15 0
" " (three months)	202 2 6
Copper (cash)	79 2 6
" (three months)	75 15 0
Spanish Lead (cash)	24 8 9
" " (three months)	24 2 6
Spelter (cash)	26 7 6
" (three months)	26 13 9
MANCHESTER—	
Copper, Best Selected Ingots	81 0 0
" Electrolytic	85 0 0
" Strong Sheets	112 0 0
" Tubes (Basis Price), lb.	0 1 3½
Brass Tubes (Basis Price), lb.	0 1 1½
" Condenser, lb.	0 1 3½
Lead, English	26 0 0
" Foreign	24 10 0
Spelter	26 17 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/- per lb.	
Ferro Tungsten	2/10 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 0 0	7/6
" " 6 p.c. to 8 p.c.	£24 0 0	7/-
" " 8 p.c. to 10 p.c.	£23 10 0	6/-
" " Specially refined		
" " Max. 2 p.c. carbon	£38 0 0	12/-
" " " 1 p.c. carbon	£40 0 0	15/-
" " " 0·70 p.c. carbon	£45 0 0	17/-
" " " carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home	
	£13 10 0 for export	
" Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
" " 75 p.c.	£19 10 0 scale 6/- per unit	
" Vanadium	13/6 per lb.	
" Molybdenum	3/9 per lb.	
" Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	13/6
" " Ell	14/6
" " Splint	15/6 to 16/3
" " Trebles	14/-
" " Doubles	13/-
" " Singles	12/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/-
" " Jewel	17/6
" " Trebles	13/9
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	12/- to 13/6
Screened Navigation	17/6
Trebles	14/-
Doubles	13/-
Singles	12/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	13/-
Secondary Steam	12/6
Trebles	14/-
Doubles	13/-
Singles	12/-

ENGLAND.

(8) N.W. COAST—	
Steams	24/- to 25/-
Household	38/- to 51/-
Coke	23/6 to 24/-
NORTHUMBERLAND—	
Best Steams	14/6 to 15/-
Second Steams	13/6 to 13/9
Steam Smalls	9/6 to 10/6
Unscreened	13/- to 13/3
Household	21/- to 26/-
DURHAM—	
Best Gas	15/6
Second	15/- to 15/3
Household	21/- to 27/-
Foundry Coke	21/- to 26/-

SHEFFIELD—	Inland.	Export.
Best Hand-picked Branch	27/- to 28/6	—
Derbyshire Best Bright House	20/- to 23/-	—
Best House Coal	19/6 to 20/6	—
Screened House Coal	17/6 to 18/6	—
" " Nuts	16/- to 17/6	—
Yorkshire Hards	15/6 to 16/6	—
Derbyshire Hards	15/6 to 16/6	—
Rough Slacks	8/6 to 9/6	—
Nutty Slacks	6/- to 7/-	—
Smalls	2/- to 4/-	—
Blast-furnace Coke (Inland)	14/6 at ovens	—
Furnace and Foundry Coke (Export), f.o.b.		20/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/6 to 21/-
Second Smokeless Large	20/- to 20/6
Best Dry Large	19/9 to 20/-
Ordinary Dry Large	19/- to 19/6
Best Black Vein Large	19/9 to 20/-
Western Valley Large	19/6 to 19/9
Best Eastern Valley Large	18/9 to 19/3
Ordinary Eastern Valley Large	18/6 to 18/9
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/6 to 13/6
Washed Nuts	20/- to 24/-
No. 3 Rhondda Large	20/6 to 21/-
" " Smalls	15/- to 15/6
No. 2 " Large	17/6 to 18/-
" " Through	16/- to 17/-
" " Smalls	13/- to 13/6
Foundry Coke (export)	26/6 to 36/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/6 to 21/6
Pitwood (ex ship)	25/6 to 26/-
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	33/- to 35/-
Seconds	27/6 to 30/-
Red Vein	24/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	40/- to 44/-
Beans	23/6 to 25/6
Peas	17/3 to 18/6
Breaker Duff	9/- to 9/6
Rubbly Culm	9/3 to 9/9
Steam Coals :	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	10/6 to 13/-
Cargo Through	15/9 to 16/9

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield.

(*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products.

French Engineering Notes.

(From our Correspondent in Paris.)

Paris Water Supply.

PRELIMINARY arrangements for carrying out the scheme to supply Paris with water from the Vals de Loire are being pushed forward, despite the opposition encountered from the local populations. Some of the Chambers of Commerce have given a qualified approval on condition that the scheme does not prejudically affect local interests, and it is upon that point that a solution of the whole matter rests, for the Chambers of Commerce do not believe that a million cubic metres of water can be pumped daily from the subterranean supplies in the Vals de Loire without lowering the water level in it and thereby depriving local users of supplies, and probably, also, reducing the level of the river itself. The Minister of Public Works has, therefore, constituted a commission of inquiry to be composed of eminent experts from the geological section of the Académie des Sciences and other bodies. Only if this commission offers no objection to the scheme will the Paris Municipality and the Prefect of the Seine take the necessary measures to carry it out. In view of the pumping involved in order to raise such a large quantity of water daily to be sent to Paris, mainly by gravitation, the enterprise is one of special interest.

Distillation of Lignite.

While in Germany lignite is utilised to the fullest possible extent, either in the form of fuel or for the sake of by-products from carbonisation, very little has been done with the lignite deposits in France, which are generally of so poor a quality that nearly all attempts to exploit them have failed. There are very extensive deposits, notably in the Gard, but the lignite has to be worked underground, and it contains from 25 to 40 per cent. of ash. It is now hoped to make economic use of the lignite by a process which is being tried by the Charbonnages de la Tave, in the Gard, whereby the fuel is carbonised and the gases are treated by catalysers. The coke is stated to have a sufficient heat value to be used as a fuel, although on account of the high percentage of ash it can, for the most part, only be used when mixed with other fuels. The carbonising plant consists of a steel oven with a perforated tube through the centre for the discharge of the gases, while the coke is removed continuously by a helical conveyor, the heat of the coke being employed to raise the temperature of the air entering the combustion space. The gases are first freed from sulphur in a scrubber, then pass through batteries of catalysers, and after condensation and the separation of ammoniacal liquor, the resultant product is lignite oil. A ton of lignite containing 18 per cent. of ash and 15 per cent. of water is said to produce 65 litres of crude oil and 650 kilos. of coke, containing 25 per cent. ash and 12 per cent. of volatile matter. From the oil there are obtained 11½ litres of motor spirit, 21 litres of paraffin, 19½ litres of heavy oil for Diesel engines, and from 8 kilos. to 10 kilos. of tar products. A similar method for treating coke oven gases is being employed in the north of France, but no definite details are yet forthcoming as to its economical success.

Gustave Eiffel.

A statue of the late Monsieur Gustave Eiffel has been placed, with official ceremony, at the base of the tower bearing his name, and many reminiscences are revived of the origin of what, at the time, was regarded as a construction of so bold and hazardous a character as to arouse almost general opposition. Eiffel had to fight hard for permission to build the tower, and it was erected for the Universal Exhibition of 1889, on the understanding that it should be pulled down in eleven years' time. On being asked what useful purpose the tower would serve, Eiffel replied that he did not know, but that it would certainly be useful. It proved to be invaluable for military purposes, and while still in military occupation, the tower is employed mainly for broadcasting. It was at the foot of the tower that Eiffel installed his first aerodynamic laboratory for determining the streamline forms of aeroplanes, and he thereby initiated the science of aerodynamics as applied to aviation.

Prospecting for Minerals.

The discovery of minerals, oils, and water by apparatus depending for their operation upon magnetic effects has been claimed by several inventors, and at one time great prominence was given to surprising results that were said to have been obtained by a French inventor. Another apparatus has been presented by a German inventor, who has just carried out tests in the Bois de Vincennes in the presence of a number of engineers and scientists. Its form resembles that of a gun shell. It rests on a helical spring and a pivot, so that, when held vertically between the fingers of each hand, the shell is free to turn. It contains certain products stated to have an affinity with the minerals sought for. With a metal object placed under a table, the apparatus certainly gave accurate indications in the hands of the inventor, moving more or less slowly according to the distance from the metallic object, and spinning when directly over it, but none of the others present could get the apparatus to work at all. Tests carried out in the Bois de Vincennes, where objects had been concealed, were not conclusive.

Coal.

Prices of industrial coal have been advanced this week in order to compensate for the increase in miners' wages, and the character of the competition of foreign coal is shown by the way in which the advance is adjusted in various districts according to the facilities offered for the importation of British and Belgian fuels. This makes it fairly obvious that French coalowners experience difficulty in meeting such competition.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

308,487. April 10th, 1928.—EXHAUST SILENCERS, C. H. Brice, 13, Warleigh-road, Brighton.

It is hardly necessary to go beyond the preamble of the specification in this case, as the drawing shows the construction of the apparatus so plainly. It is explained that the silencer has a plurality of ducts or passages of varying lengths, so arranged that exhaust gas entering the silencer will be split

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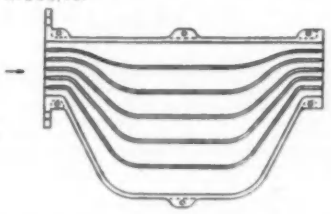

up into a number of separate columns. Owing to the varying lengths of the ducts different periods of time are taken for the columns of gas passing therein to travel between the inlet and outlet ends of the silencer, so that although entry of gas into the silencer takes place simultaneously in the case of all the ducts, the discharge from the said ducts is not simultaneous, but spread out over a slight period of time.—*March 28th*, 1929.

DYNAMOS AND MOTORS.

308,286. December 8th, 1927.—MEANS FOR REGULATING THE SUPPLY OF CURRENT FROM DYNAMOS HAVING A THIRD BRUSH FOR USE IN POWER-DRIVEN VEHICLES, Guido Fornaca, of 7, Via Giannone, Turin, Italy.

The windings A and B are so dimensioned that, together, they supply the maximum excitation corresponding to maximum supply of current and the winding A alone gives a reduced excitation. As long as the switch C is in the "off" position the dynamo is excited only by the main winding A producing the current curve X in the lower diagram, in which the ordinates indicate the charging current supplied in ampères and the abscissæ indicate the armature revolutions per minute. In this way the lower charging stage is obtained with reduced danger

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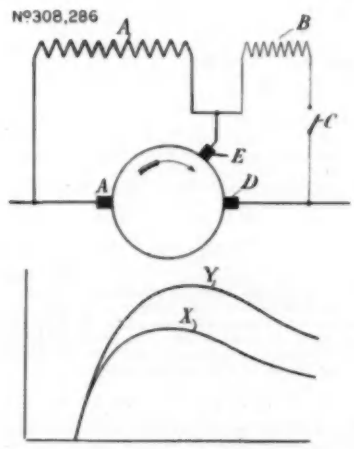

of the battery becoming overcharged. When, however, the switch C is in the "on" position the excitation is increased by the action of the winding B giving the current curve Y corresponding to the higher charging rate. With increasing speeds of rotation the voltage between the brushes E and D and the current in the winding B increase so that with high speeds of rotation the lower effect of the winding A due to the system with a third brush is compensated for and the maintenance of a maximum supply of current ensured. By means of the arrangement described the driver may vary the battery charging current according to requirements, but the charging current can never be entirely interrupted, and in consequence the battery will never be completely discharged.—*March 8th*, 1929.

308,384. December 31st, 1927.—ALTERNATING-CURRENT DYNAMO-ELECTRIC MACHINES, Sachsenwerk Licht- und Kraft-Aktiengesellschaft, of Niedersedlitz, Dresden, Germany; and Tom Schmitz, of Lindenaustrasse, 17/II., Dresden, Germany.

The diagram shows a known machine for the purpose of phase compensation in induction motors comprising a rotor A provided with a direct-current commutator winding and a stator which carries a compensating winding B and an exciting winding C which is connected to the terminals of the machine and is therefore situated in shunt to the commutator and compensation winding. With a brush displacement of 90 deg. from the axis of the exciting winding the current flowing through the exciting winding is in phase with the electromotive force induced in the rotor of the phase displacer. In order to obtain a phase compensation that is as perfect as possible the machine is designed so that for normal working the angle between the slip voltage of the principal motor and the electromotive force induced in the rotor of the phase displacer is a right angle. Experience shows that a machine constructed according to these principles has a tendency to oscillate. The invention provides a means which permits an approximately even compensation from full load to no load without oscillation. In addition to the shunt excitation a slight series excitation is imparted to the machine by giving to the compensating winding 5 to 30 per cent. more ampère turns than to the commutator winding. Owing to the voltage induced by the main current field in the armature winding, a factor is introduced in the determinations for the working

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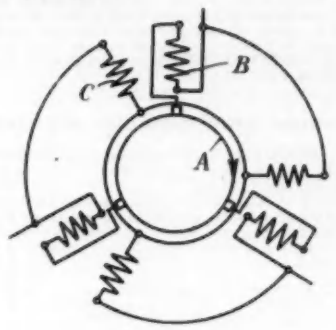

diagram whereby the difficulties which have hitherto occurred are obviated.—*March 28th*, 1929.

TRANSMISSION OF POWER.

308,521. June 2nd, 1928.—LEAD COVERING OF ELECTRIC CABLES BY EXTRUSION, W. T. Henley's Telegraph Works Company, Ltd., of 11, Holborn-viaduct, London, E.C. 1; and Ernest Edward Judge, of 66, Pelham-road, Gravesend.

The invention relates more particularly to the nose or point of the die used for the lead covering of cables by extrusion. It has been found that the die is liable to become displaced longitudinally by the pressure on the lead to be extruded, and the chief aim is to prevent or to reduce this longitudinal movement. The nose or point A is slidably mounted in a ring B which is itself mounted at the forward end of the main tubular carrier C so as to abut against a shoulder D formed in the carrier C, whilst the nose or point A is adapted to abut against the forward end of a tubular distance piece E placed in the tubular carrier C from the forward end and adapted to abut against a shoulder F formed in the carrier C near its rear end. The ring B may be formed internally with holes or recesses for engagement by a key to facilitate withdrawal of the ring B from the

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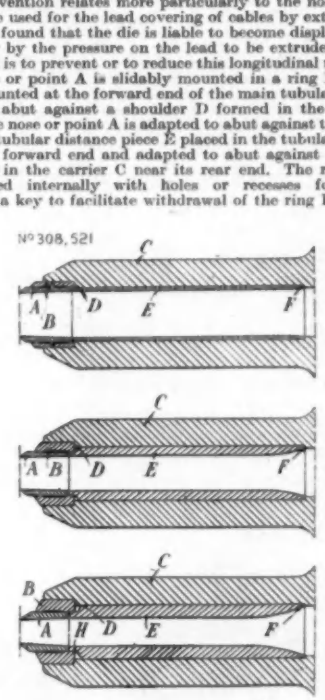

main carrier C. As shown in the two lower drawings, the thicknesses of the ring B and of the distance piece E is increased as the size of the nose or point A is decreased, the forward end of the distance piece being shouldered as at H and spaced from the adjacent end of the ring B. In use the pressure of the lead to be extruded acting against the combined end area of the main carrier C and ring B may cause the forward parts of those members to be forced back slightly, in which case they will slide relatively to the nose or point A and the tubular distance piece E, whilst the pressure acting against the relatively smaller end area of the nose or point A will be resisted by the tubular distance piece E which abuts against the shoulder F at the rear end of the main carrier C which is not liable to be moved. Moreover, the pressure acting against the nose or point A will be less than that acting against the ring B and carrier C, because the former is immediately opposite the open end of the die and also because a reduced area is presented to the pressure of the lead.—*March 28th*, 1929.

MEASURING AND TESTING INSTRUMENTS.

308,673. October 24th, 1927.—MEASURING INSTRUMENTS, *Albert Edward O'Dell, of 285, High Holborn, London, W.C.1.*

The pointer A of a measuring instrument, of which the

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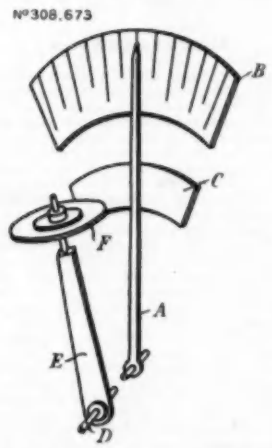

indications are to be transmitted to a distant point, swings freely before a scale B and fixed sector C. A shaft D is rotated

continuously in a clockwise direction by a motor, and carries a member E provided with a wheel F. The rim of the wheel F is composed of rubber or other elastic material, and it is large enough not to push the pointer A before it. During rotation of the shaft D, the wheel F runs over the pointer A, and presses it against the sector C, and thus holds it fast. Simultaneously a contact is closed. In this way contact is made exactly at the point where the pointer is situated, so that the correct magnitude of movement of the pointer is transmitted to the receiver.—*March 25th*, 1929.

PUMPING AND BLOWING MACHINERY.

308,442. March 2nd, 1928.—Centrifugal Pumps, Drysdale and Co., Ltd., Bon-Accord Works, Ferry-road, Yoker, Glasgow, and J. Young.

The object of this invention is to prevent the air-locking of centrifugal pumps dealing with liquids containing a considerable amount of air, or gas, and in this connection it is put forward as being especially applicable to lubricating systems in which the

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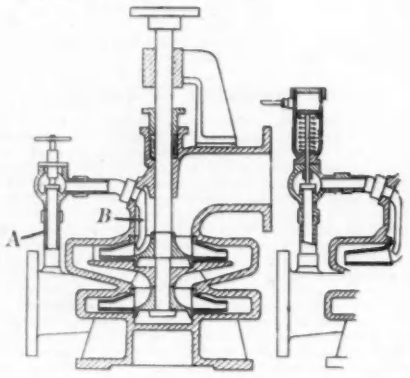

lubricant is used over and over again. The tendency is for an air lock to form about the inlet eye of the impeller, so the inventors provide a by-pass A from the discharge branch. This by-pass terminates in a nozzle B which is so arranged that "the injected stream is substantially parallel with the direction of flow of the inflowing liquid being pumped." The by-pass is controlled by a valve, which may be operated automatically by the pressure in the discharge branch.—*March 28th*, 1929.

MACHINE TOOLS AND SHOP APPLIANCES.

308,489. April 11th, 1928.—Shaft Bearings, British Celanese, Ltd., 8, Waterloo-place, London, S.W. 1, and E. C. Cope, Spondon, near Derby.

This bearing is intended for use in connection with spindles which run at "very high speeds," such as those of spinning

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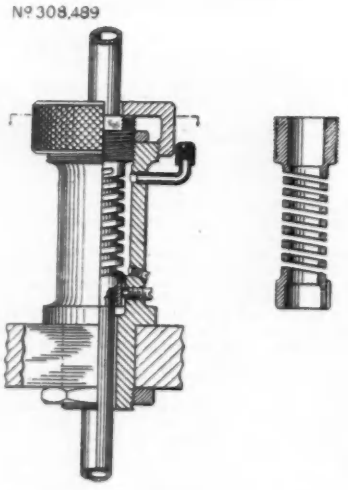

machinery. The bearing itself takes the form of a helix, one end of which is fixed in the housing, while the other end is connected with a sleeve that may be turned and locked so as to increase or decrease the internal diameter of the helix to suit the size of the journal.—*March 28th*, 1929.

MISCELLANEOUS.

308,647. December 24th, 1927.—Condenser Tubes, R. S. Hutton, The British Non-Ferrous Metals Research Association, 71, Temple-row, Birmingham.

In this specification it is explained that considerable research has been carried out on the alloys most suitable for condenser tubes, and that tests have been carried out over a period of nine months in an experimental condenser using sea water flowing at a speed of 7ft. per second, and moderately aerated, so as to contain air in the form of bubbles, thus providing conditions which are known to cause considerable erosion or impingement attack. A comparison of tubes made (*a*) of 70 per cent. copper plus 30 per cent. zinc; (*b*) a similar tube containing 0·2 per cent. arsenic; and (*c*) 76 per cent. copper, 22 per cent. zinc, 2 per cent. aluminium, have clearly demonstrated the superiority and exceptional corrosion-resisting properties of the aluminium-brass condenser tubes comprised in this invention, for whereas the 70 : 30 brass tube after its nine months' test exhibited marked erosive thinning at the inlet end of the water stream and general corrosive attack accompanied by severe dezincification throughout the whole length of the tube, and the 70 : 30 arsenical tube severe erosive thinning and general corrosion, but without dezincification, the aluminium-brass tube was almost completely unattacked, its internal surface still exhibited a bright yellow brass colour, and no erosive thinning at the inlet end. The inventor consequently claims for an alloy of 71 per cent. or more of copper, aluminium up to 5 per cent., and the remainder of zinc. He gives some instructions as to the proper pouring of the ingots.—*March 25th*, 1929.

284,325. January 20th, 1928.—Electric Bell Installations Fed from Small Transformers, *Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.*

When electric bells are fed from small transformers the idle working losses exceed the useful work and the annual efficiency is very low. The object of this invention is to improve the annual efficiency, and this is done by making the transformer A charge

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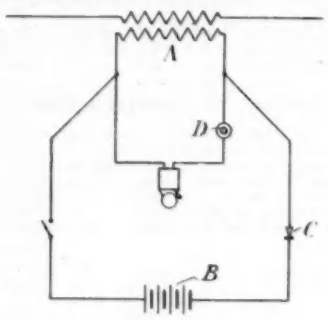

a battery B through a copper oxide rectifier C. The battery may be used, for example, for heating the filaments of thermionic valves. The working of the bell, which is controlled by the push button D, is in no way affected by the presence of the rectifier. The bell in the case illustrated is of the alternating-current type, but a direct-current bell can be employed by inserting a rectifier in the bell circuit.—*April 4th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London. Special general meeting with a view to considering and, if thought fit, passing resolutions as to a petition for a Royal Charter. 6 p.m.

Institution of Municipal and County Engineers.—Kenilworth Castle, Kenilworth. 10.45 a.m. Abbey Hotel, Kenilworth. Discussion on papers: "Stare Bridge," by Mr. D. H. Brown; "Kenilworth: Castle and Town," by Mr. Sholto Douglas. 5.30 p.m.

Keighley Association of Engineers.—At the Queen's Hotel, Keighley. Annual general meeting. Presidential address. 8 p.m.

Physical Society.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "Heaviside's Fractional Differentiator," by Dr. W. E. Sumpner; "A Simple Method of Fitting a Straight Line to a Series of Observations," by Mr. J. H. Awbery; "Arc Spectra in the Region λ 1600–λ 2100," by Mr. E. W. H. Selwyn; "The Spectrum of Trebly-ionised Thallium," by Dr. K. R. Rao; "The Elastic Properties of Thick Cylindrical Shells under Internal Pressure," by Mr. G. A. Wedgwood. A demonstration relating to standards of length and mass will be given by Mr. J. E. Sears. 4.45 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse "The Twist of Snail Shells," by Professor E. A. Boycott, F.R.S. 9 p.m.

SATURDAY, MAY 11th.

Institution of Municipal and County Engineers.—South Wales District meeting, Swansea. 11 a.m. Council Chamber, Guildhall, Swansea. Discussion on papers: "Some Road and Other Schemes at Swansea," by Mr. Robert Hudson; "Swansea Main Drainage Scheme and Flood Relief Schemes," by Mr. J. Hassall; "Llansamlet Sewage Pumping Scheme, Swansea," by Mr. M. E. Habershon. 3.15 p.m.

SUNDAY, MAY 12th.

Institution of Civil Engineers: Manchester and District Association.—Visit to the Castleton District of Derbyshire. Leave Albert-square, Manchester, at 2 p.m.

TUESDAY, MAY 14th.

Illuminating Engineering Society.—32, Victoria-street, London, S.W. 1.—In the Lecture Theatre at the Home Office Industrial Museum, Horseferry-road, Westminster, S.W. 1. A paper reviewing the proceedings at the meetings of the International Commission on Illumination and on the International Congress held in the United States in 1928 will be read by Mr. G. H. Wilson and will be followed by a discussion. 6.15 p.m.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Annual general meeting. 6 p.m.

Institution of Petroleum Technologists.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Flame Characteristics of 'Pinking' and 'Non-pinking' Fuels," Part II., by Mr. G. B. Maxwell and Dr. R. V. Wheeler. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. "Analysis of Monsieur Fayol's Theory of Subsidence," by Professor Owen T. Jones, F.R.S., and discussion. There will be the following exhibit. "Boulders from Coal Seams in the Lancashire Coalfield," by Dr. M. B. Hodge. 4 p.m.

Royal Institute of British Architects.—Merchant Taylor's Hall, London. Annual dinner.

TUESDAY AND WEDNESDAY, MAY 14th and 15th.

Society of Glass Technology.—Meetings in London. Tuesday, 2 p.m., visit to Research Laboratories of the General Electric Company, Ltd., Wembley; 2.30 p.m., Council meeting; 4 p.m., joint meeting with the Physical Society at Wembley; 5 p.m., tea at Wembley; evening, visit to Osram G.E.C. Glass Works, Wembley. Wednesday, 10 a.m., visit to Laboratories of British Association of Research for the Cocoa, Chocolate, Sugar, Confectionery and Jam Trades at Holloway; 2.30 p.m., general meeting, University College Gower-street; inauguration of London Section of the Society of Glass Technology; 7 p.m., annual dinner, Monico Restaurant.

TUESDAY, MAY 14th, TO OCTOBER.

North-East Coast Exhibition.—Newcastle-on-Tyne.

WEDNESDAY, MAY 15th.

Royal Meteorological Society.—49, Cromwell-road, South Kensington. "Report on the Phenological Observations in the British Isles, December, 1927, to November, 1928," by Messrs. J. Edmund Clark, I. D. Margary, R. Marshall, and C. J. P. Cave; "The Index of Refraction of Damp Air and the Optical Determination of Lapse-rate," by Mr. D. Brunt; "The Influence of Smoke and Hot Gases from Factory Chimneys on Rainfall," by Dr. J. Reginald Ashworth. 5 p.m.

Royal Society of Arts.—John-street, Adelphi, London, W.C. 2. "Reform of the British Patent System," by Mr. Robert Burrell. 8 p.m.

WEDNESDAY TO THURSDAY, MAY 15th to 23rd.

World Power Conference.—Sectional meeting, Barcelona. Conference on complete utilisation of water power resources. For programme see page 291, March 15th, 1929.

THURSDAY, MAY 16th.

Institution of Civil Engineers: Yorkshire Association.—Hotel Metropole, Leeds. Annual general meeting. 7.30 p.m.

Institution of Mechanical Engineers: Yorkshire Branch.—Visit to the works of Hopkinsons Ltd., Britannia Works, Huddersfield. 2.30 p.m.

WEDNESDAY TO FRIDAY, MAY 22nd to 24th.

Institution of Water Engineers.—Birmingham. Summer general meeting. For programme see page 352, March 29th, 1929.

THURSDAY, MAY 23rd.

Faraday Society.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, W. Annual general meeting, to read and discuss the Third (Experimental) Report to the Atmospheric Corrosion Research Committee (British Non-Ferrous Metals Research Association), presented by Mr. J. C. Hudson. 7.45 p.m.

TUESDAY TO FRIDAY, JUNE 4th to 7th.

Institution of Gas Engineers.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual general meeting. 10 a.m. each morning.

WEDNESDAY TO SATURDAY, JUNE 5th to 15th.

International Foundry Trades' Exhibition.—Royal Agricultural Hall, Islington, London, N. 1.

FRIDAY TO THURSDAY, JUNE 7th to 13th.

Institution of Gas Engineers.—Visit to Berlin for the meetings of the German Gas and Water Association, and to visit the German Gas and Water Exhibition.

THURSDAY TO SATURDAY, JUNE 6th to 15th.

International High Tension Conference.—Paris. For provisional details see page 413, April 12th, 1929.

TUESDAY TO SATURDAY, JUNE 11th to 22nd.

Institution of Electrical Engineers.—France. Summer meeting. For programme see page 331, March 22nd, 1929.

TUESDAY TO FRIDAY, JUNE 25th to 28th.

Institution of Mechanical Engineers.—Manchester. Summer meeting. For programme see page 302, March 15th, 1929.

TUESDAY TO THURSDAY, JULY 2nd to 4th.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. Summer meeting in Newcastle-upon-Tyne, jointly with the Institution of Engineers and Shipbuilders in Scotland.

The Institution of Civil Engineers: Awards for Papers.—The Council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1928–1929:—A *Telford Gold Medal* and a *Telford Premium* to Mr. Conrad Gribble, M. Inst. C.E.; a *George Stephenson Gold Medal* to Mr. Harry Hall, M. Inst. C.E.; *Telford Premiums* to Messrs. N. H. Colam, Assoc. M. Inst. C.E.; F. W. A. Handman, M. Inst. C.E.; T. P. M. Somers, M. Inst. C.E.; H. V. C. Johnstone, M. Inst. C.E.; and jointly to J. H. Hyde, Assoc. M. Inst. C.E., and H. R. Lintern, Assoc. M. Inst. C.E.

Royal Institution.—The annual meeting of the members of the Royal Institution was held on Wednesday afternoon, May 1st, Sir Arthur Keith, treasurer and vice-president, in the chair. The annual report of the Committee of Visitors for the year 1928, testifying to the continued prosperity and efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was also read. Sixty new members were elected in 1928, and sixty-four lectures and nineteen evening discourses were delivered. The books and pamphlets presented amounted to about 181 volumes, making with the 712 volumes—including periodicals bound—purchased by the managers, a total of 893 volumes added to the library in the year. Thanks were voted to the President, Treasurer and Secretary; to the Committees of Managers and Visitors, and to the Professors, for their services to the Institution during the past year. The following were unanimously elected as offices for the ensuing year:—President, The Duke of Northumberland; Treasurer, Sir Robert Robertson; Secretary, Major Charles E. S. Phillips; Managers, The Right Hon. Lord Blanesburgh, Ernest Clarke, Sir James Crichton-Browne, Frederick C. Donnan, W. H. Eccles, W. Vaux Graham, J. S. Highfield, Sir Arthur Keith, V. Warren Low, Charles H. Merz, Robert Mond, Sir Richard Paget, C. C. Paterson, George C. Simpson, and W. J. Tennant; Visitors, M. Atkinson Adam, Edward N. da C. Andrade, James H. Batty, Frederick H. Berryman, Montague Ellis, Kenneth R. Hay, David Heron, G. W. C. Kaye, William Macnab, Emile S. Mond, Hugh Munro Ross, Walter S. Rowntree, Sidney Skinner, Harold R. D. Spitta, and Alfred E. Western.—A general meeting was held on Monday afternoon, May 6th, Sir Robert Robertson, Treasurer, in the chair. The Chairman announced that the President, the Duke of Northumberland, had nominated the following as Vice-Presidents for the ensuing year:—Lord Blanesburgh, Sir James Crichton-Browne, Dr. W. H. Eccles, Sir Arthur Keith, Mr. C. H. Merz, Dr. G. C. Simpson, Sir Robert Robertson (Treasurer), and Major C. E. S. Phillips (Secretary). The special thanks of the members were returned to Sir Dugald and Lady Clerk, Lady Dewar, Mr. T. H. Sowerby and Mr. A. A. Campbell Swinton for their donations to the special fund for the alterations in the building. Sir J. J. Thomson was elected Honorary Professor, and Sir Ernest Rutherford, Professor of Natural Philosophy. Mr. C. E. R. Brocklebank and Mr. F. L. Pearson were elected members.